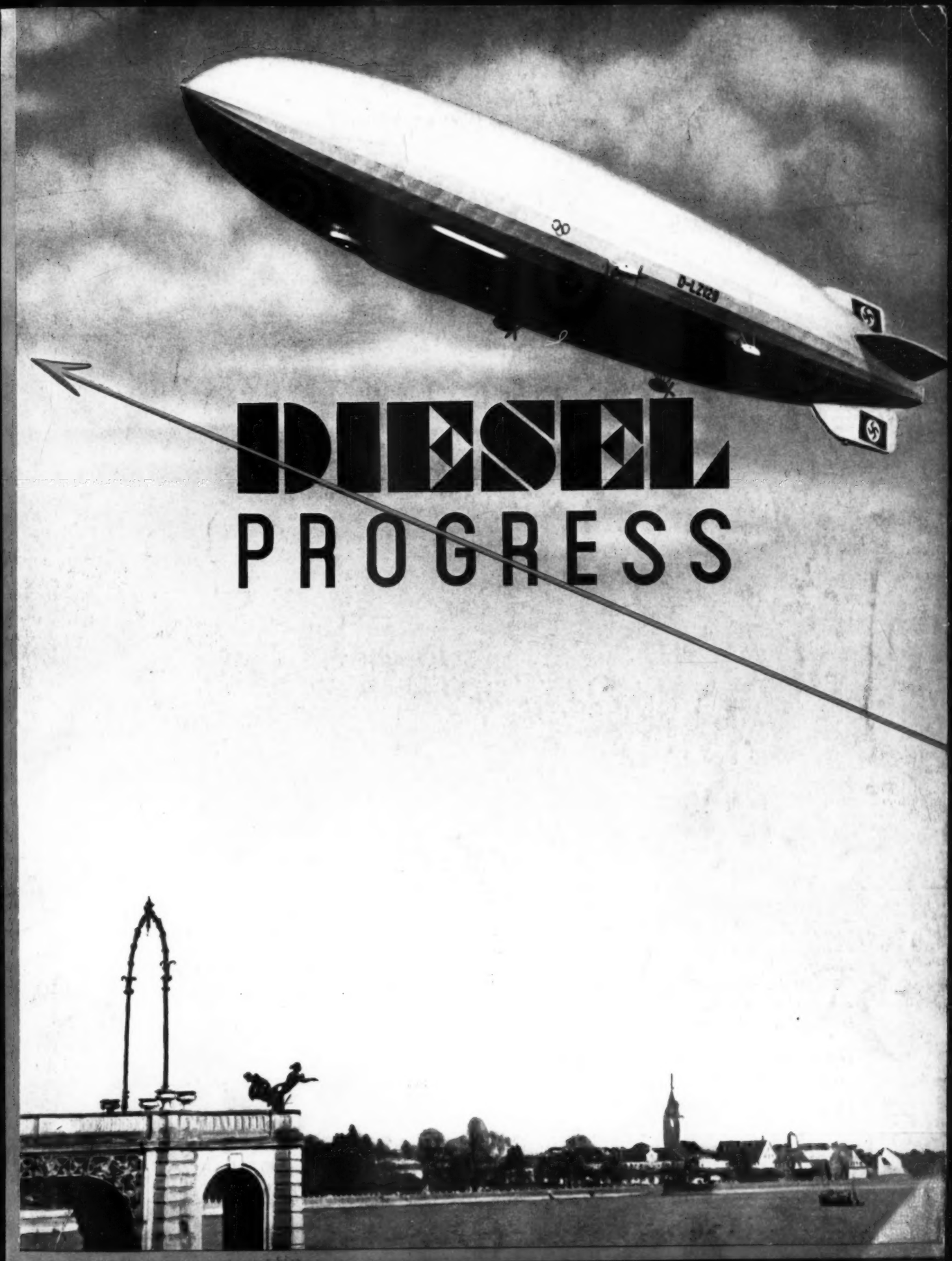


DIESEL PROGRESS

IN INDUSTRY • IN TRANSPORTATION • ON THE SEA • IN THE AIR

MAY, 1937 CIRCULATION OF THIS ISSUE—IN EXCESS OF 11,000 COPIES 25c

Actual photographs of a Gulf engineer consulting with the manager of a large Diesel power plant regarding lubrication. Every day, throughout 28 states from Maine to Texas, Gulf engineers are "in the picture" in scores of plants—helping to reduce operating costs through better lubrication with Gulf oils and greases.

HE KNOWS *Diesel Lubrication!*

Keep the Gulf Engineer "IN THE PICTURE" *in your plant*

It's A Big Plus Value! This engineering service, extended to users of Gulf Diesel lubricants is worth real money.

Here's the reason. Maintenance costs—say Diesel operators—have a direct relationship to the efficiency of lubrication. And—proper application of the right oils and greases protects cylinders, pistons and bearings against wear, avoids excessive carbon formation and saves the cost of overhauling.

The Gulf engineer's purpose is to increase the efficiency of Diesel operation through improved lubrication. His recommendations as to the selection and application of lubricants to Diesel equipment are a PLUS VALUE which Gulf users receive.

More than fifty of America's foremost Diesel engine builders have approved Gulf Diesel lubricants for the engines they build. Let a Gulf engineer recommend the best lubrication practice for your equipment.

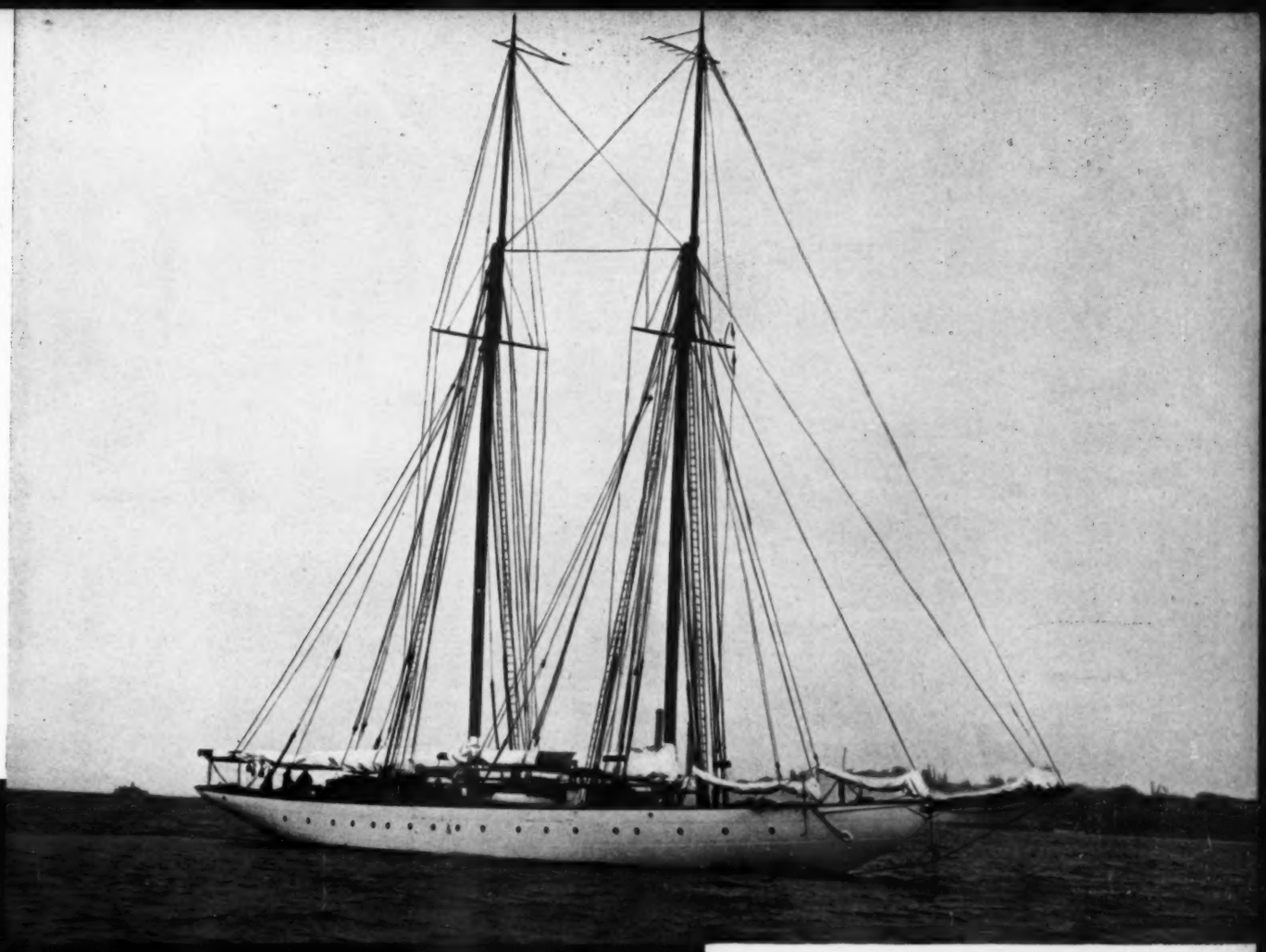
GULF INDUSTRIAL LUBRICATION

GULF OIL CORPORATION · GULF REFINING COMPANY

GENERAL OFFICES: GULF BUILDING, PITTSBURGH, PA.

MAKERS OF GULF NO-NOX ETHYL GASOLINE AND GULFPRIDE OIL

DIESEL PROGRESS for May, 1937. Volume III. No. 5. DIESEL PROGRESS is published monthly by Diesel Engines, Inc., 2 West Forty-fifth Street, New York, N. Y. Rex W. Wadman, President. Acceptance under the Act of June 5, 1934, at Brooklyn, New York, authorized May 14, 1935. Subscription rates: United States and Pan American countries $3.00, Canada and all other countries $5.00 per year. Single copy price 25 cents in U.S.A., 50 cents for all other countries.



An ERIE crankshaft selected by Winton Engine Manufacturing Corporation for the 6-cylinder, 275-hp. Diesel engine installed by them in the "Goodwill".

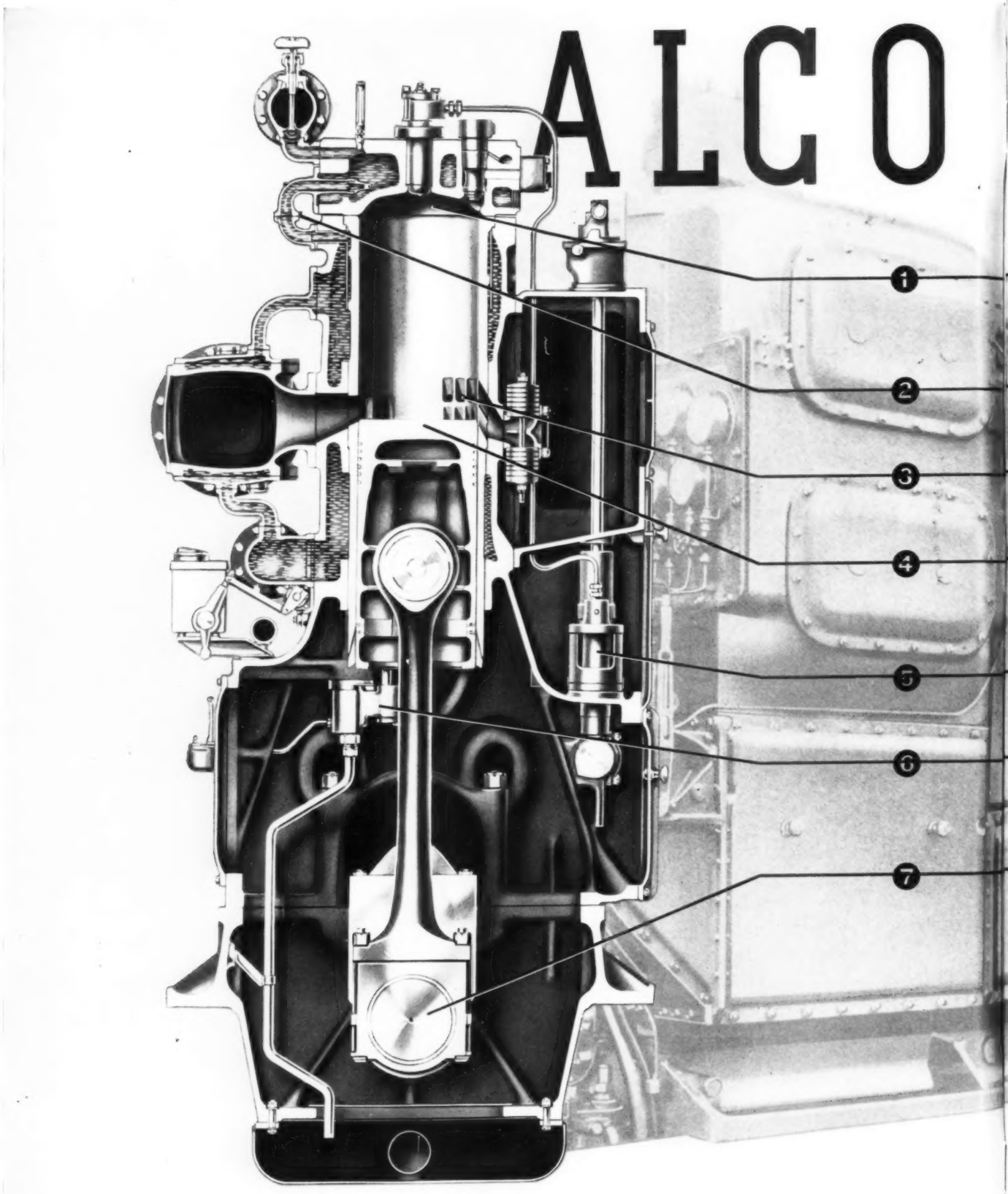
Crankshafts, connecting rods, crossheads, generator and extension shafts for all classes of stationary and marine engines.

Superior quality and accurate finish are necessary for the smooth performance of Diesel engines. Since the inception of Diesel engine use in this country, leading engine builders have relied on ERIE crankshafts for such accuracy.

Prompt delivery on all major forged or cast steel elements required in the building and powering of every type of installation.

ERIE FORGE COMPANY

ERIE PENNSYLVANIA


ALCO
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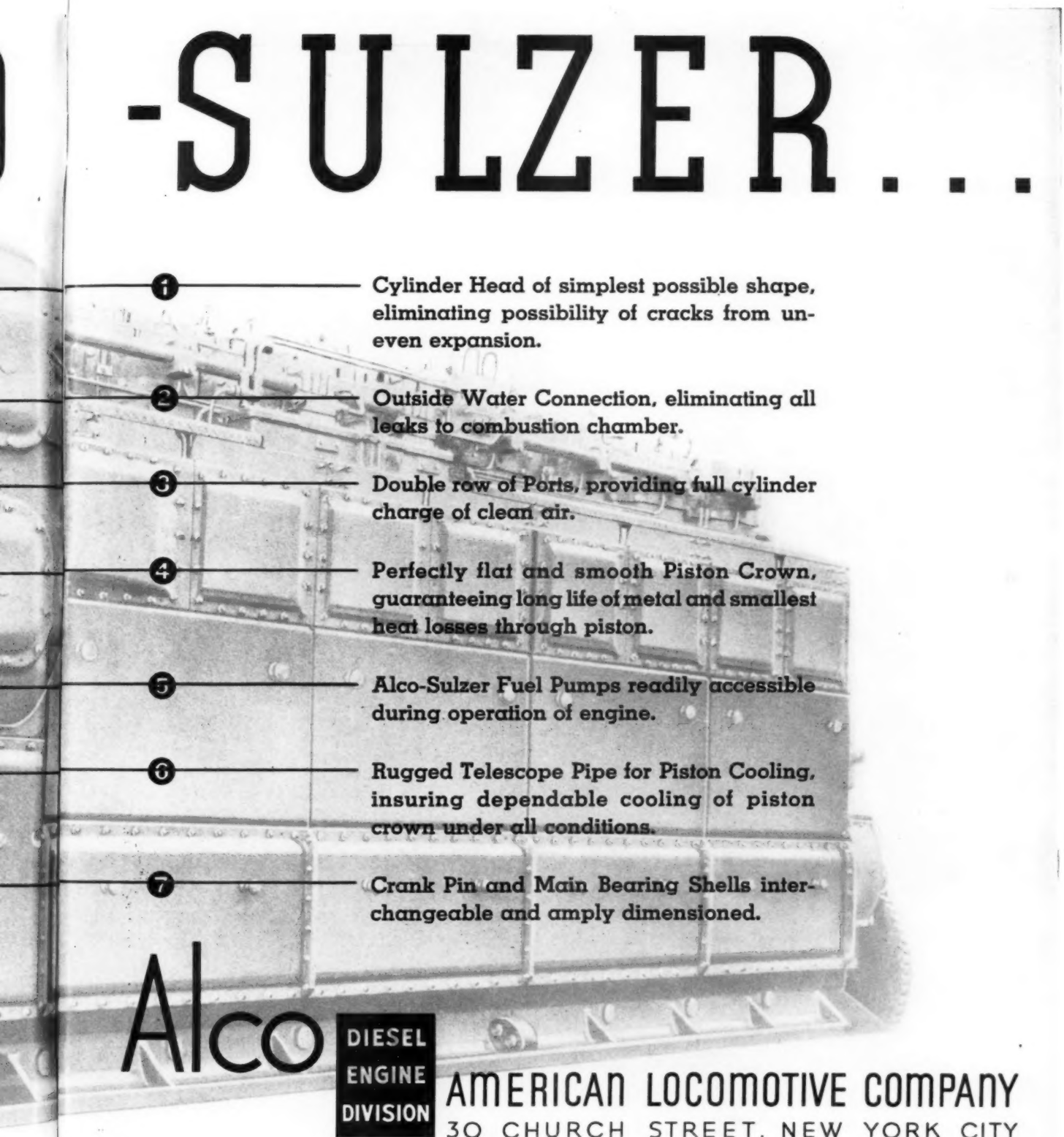
-SULZER...

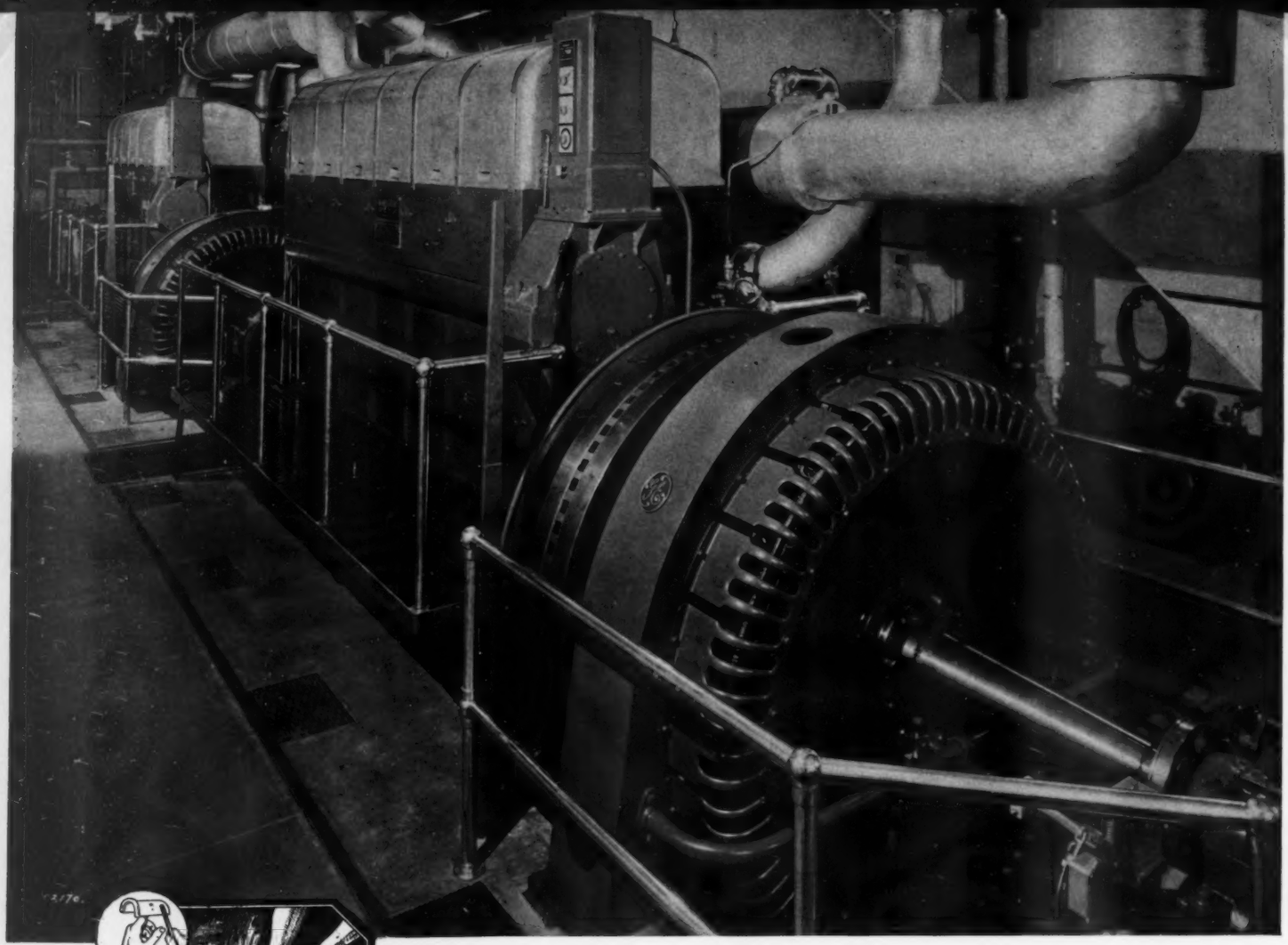


1. Cylinder Head of simplest possible shape, eliminating possibility of cracks from uneven expansion.
2. Outside Water Connection, eliminating all leaks to combustion chamber.
3. Double row of Ports, providing full cylinder charge of clean air.
4. Perfectly flat and smooth Piston Crown, guaranteeing long life of metal and smallest heat losses through piston.
5. Alco-Sulzer Fuel Pumps readily accessible during operation of engine.
6. Rugged Telescope Pipe for Piston Cooling, insuring dependable cooling of piston crown under all conditions.
7. Crank Pin and Main Bearing Shells interchangeable and amply dimensioned.

Alco DIESEL ENGINE DIVISION

AMERICAN LOCOMOTIVE COMPANY

30 CHURCH STREET, NEW YORK CITY



Two Nordberg Diesels, solid injection type, six-cylinder, four-cycle, three hundred horsepower, being operated at 255 Greene Street, New York City, by Curtis Electric Company for Sailors' Snug Harbor. This power plant serves an entire city block. The engines are fitted with Satco bearings.

DEPENDABILITY COMES FIRST

OF all the factors that influence the purchase or specification of bearings, dependability is the most important. If a bearing "can't take it" all other considerations are meaningless. Our Satco* metal bearings have demonstrated a capacity for reliable, trouble-free service in all types of Diesel installations. You know what they will do because you know what they have done. And because Satco bearings are dependable, obviously they are economical. If you want to know more about Satco or about our engineering and fabricating facilities, write.

*A patented alloy manufactured by National Lead Company. Trade-mark registered.

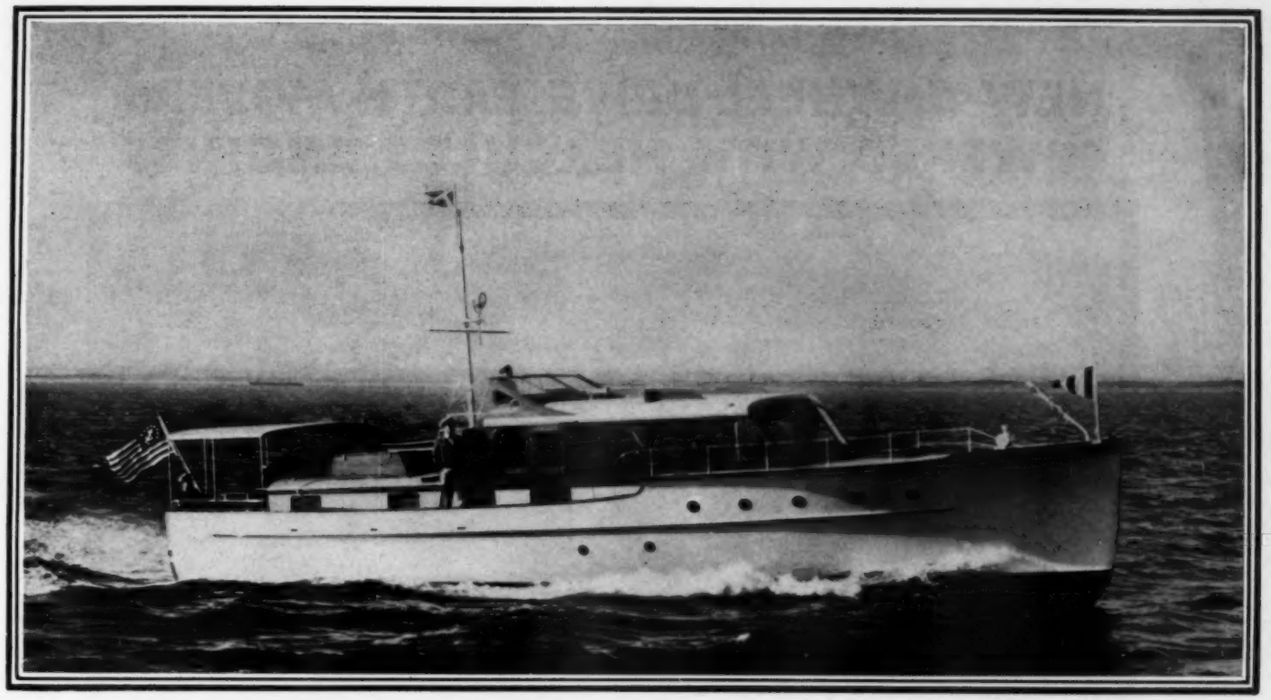
AMERICAN BEARING CORPORATION

AFFILIATED WITH NATIONAL LEAD COMPANY

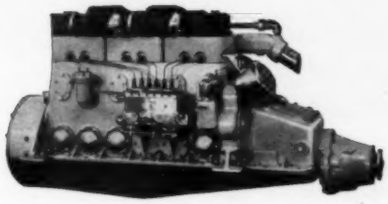
INDIANAPOLIS

CENTRIFUGAL American Bearings FORCE

INDIANA



The 53′ SUPERIOR powered Elco Motor Yacht which was exhibited at the recent New York Motor Boat Show.



That "it's always fair weather when good fellows get together" was fully emphasized by the remarkable performance of Elco's now famous 53′ Show Boat during her extensive trials.

Good fellows to be sure—a magnificent hull with the qualities of speed and seaworthiness skillfully blended and two sturdy and utterly dependable SUPERIOR Diesel engines which drive her smoothly, sweetly and safely at 17 miles per hour.

THE NATIONAL SUPPLY COMPANY

OF DELAWARE

SUPERIOR ENGINE DIVISION

LOS ANGELES, CALIFORNIA SPRINGFIELD, OHIO PHILADELPHIA, PA.

Superior DIESELS

HEAVY DUTY MODELS: 50 to 810 H.P., 250 to 720 R.P.M. • HIGH SPEED MODELS: 25 to 150 H.P., 1200 to 1800 R.P.M.

NEW 4-WHEEL-DRIVE EARTH MOVERS POWERED WITH HERCULES ENGINES

Hauling twelve-yard loads through deep sand, the new Oshkosh 4-wheel-drive earth movers—powered with Hercules Engines—are helping to push through the Knowlton Dam Project, north of Stevens Point, Wisconsin. With a speed of up to forty miles an hour, this equipment provides the contractor with a fast, rubber-tired, earth-moving unit, particularly useful where the going is tough and the time element is important. Builders of specialized, heavy-duty contracting equipment naturally turn to Hercules for rugged, dependable power plants—either gasoline or Diesel. For over twenty years Hercules has specialized in the design and construction of heavy-duty engines only. This long experience is at the service of manufacturers of powered equipment.

Hercules Marine Diesel Engines supplied by Kermath Manufacturing Company, Detroit, Michigan

HERCULES MOTORS CORPORATION, CANTON, OHIO

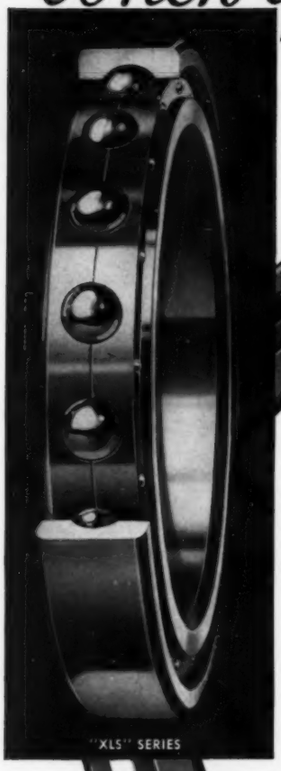
America's Foremost Engine Manufacturer

HERCULES DIESEL ENGINES

Power Plants from 4 to 200 H.P.

When You're Cramped for Space

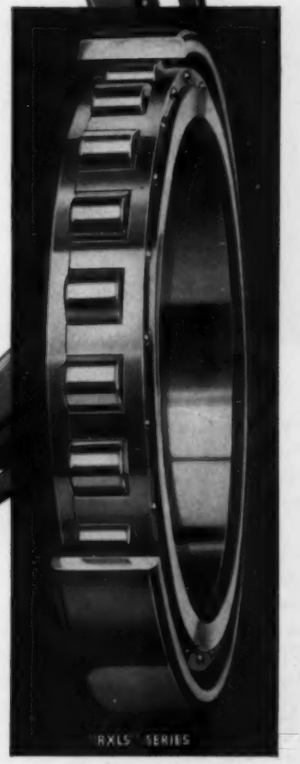
USE THESE VERY LIGHT INCH SERIES BEARINGS



HAVING bores abnormally large, as compared with the outside diameter, they offer definite advantages under certain conditions found in machine design. You may have them in several different types, *affording compactness, light weight, and greater latitude in your design.*

There are several lines of very light type ball bearings, which include the "S" starting at 1/8" bore, and the "XLS" starting at 1 3/8" bore, running up to a maximum of 21" bore and 28" outside diameter. And in very light type roller bearings, there is the "RXLS" Series, paralleling the "XLS" in size range.

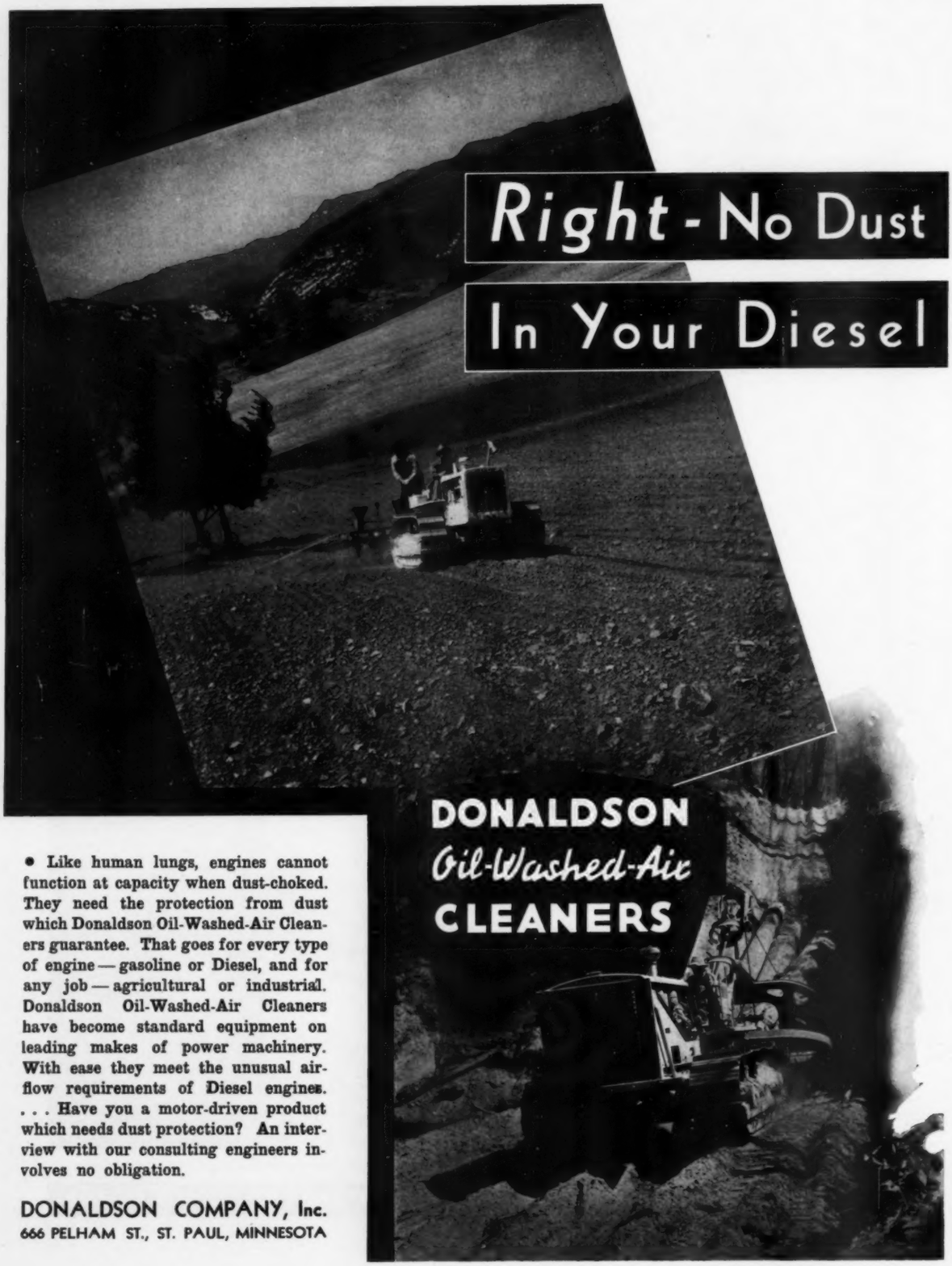
Why not let our engineers tell you more about these Very Light Precision Bearings? Write for the Catalog.



"NORMA-HOFFMANN"

PRECISION BALL, ROLLER AND THRUST BEARINGS

NORMA-HOFFMANN BEARINGS CORP'N.—STAMFORD, CONN., U. S. A.



Right - No Dust In Your Diesel

DONALDSON
Oil-Washed-Air
CLEANERS

• Like human lungs, engines cannot function at capacity when dust-choked. They need the protection from dust which Donaldson Oil-Washed-Air Cleaners guarantee. That goes for every type of engine — gasoline or Diesel, and for any job — agricultural or industrial. Donaldson Oil-Washed-Air Cleaners have become standard equipment on leading makes of power machinery. With ease they meet the unusual air-flow requirements of Diesel engines. . . . Have you a motor-driven product which needs dust protection? An interview with our consulting engineers involves no obligation.

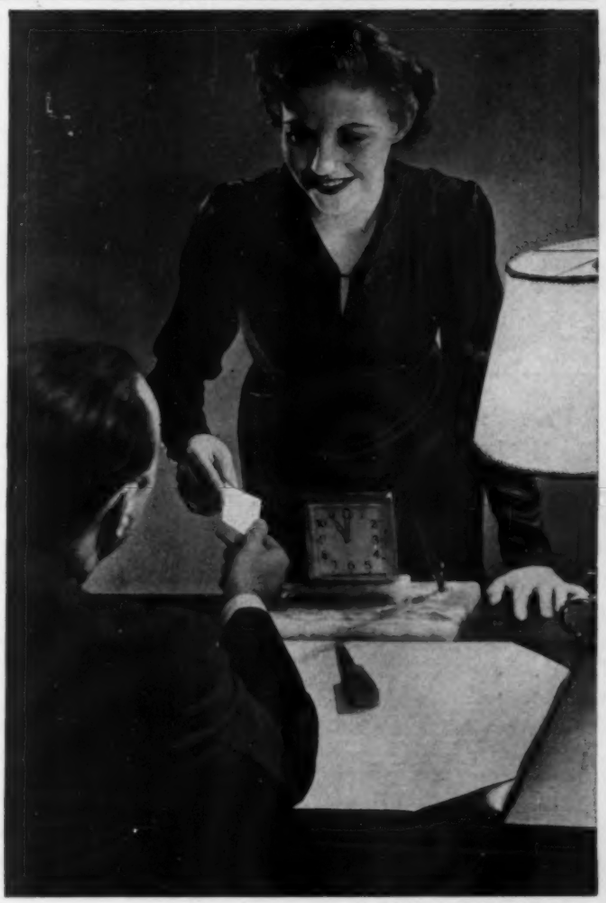
DONALDSON COMPANY, Inc.
666 PELHAM ST., ST. PAUL, MINNESOTA

"HAVE HIM COME IN"

Why is it that every day some 2,000 busy executives take time to talk to the Socony-Vacuum Representative?

Here are the Reasons:

1. He knows oils and greases... those best suited to different operating conditions.
2. He is trained in the science of "Correct Lubrication"; methods that mean efficiency—economy.
3. He is backed up by the world's most authoritative lubrication knowledge... the greatest experience in the oil industry.
4. He has the knack of cooperating with your men... helping them to devise improvements that increase manufacturing profits.



MOST INDUSTRIAL MEN—executives and shop staffs—are busy today. But never too busy to welcome one who can give real help.

Last year, Socony-Vacuum engineers were called in on over 25,000 specific industrial lubrication problems. They were consulted by 2,000 makers of new equipment about lubricating systems and methods.

More than likely, right in your own plant are opportunities to reduce costs, lower maintenance expense, improve production results, decrease lubrication bills. It might be a timely business move to find out. Socony-Vacuum will cooperate with your men whenever you give the word.

SOCONY-VACUUM
INDUSTRIAL LUBRICATION

GARGOYLE Lubricants

SAVES MONEY FOR INDUSTRY

71 Years' Lubricating Experience... the Greatest in the Oil Business

HERE'S WHAT LEADING ENGINEERS SAY ABOUT DIESEL ENGINE WEAR

"Even in its improved state the Diesel engine is subject to wear and physical depreciation during operation, like all other machinery. One of the large and expensive parts of a Diesel that undergoes rapid wear is the cylinder liner. A review of the findings of both practical experience and scientific research shows that liner wear can be attributed to a number of causes. Some of these are: inadequate lubrication, dilution of cylinder lubricant by fuel, absorption of lubricant by carbon deposits, and abrasive matter in the fuel. The last item, liner wear from abrasives in fuel used, is to a large extent beyond engine builders' control."

The above is quoted from an article written by a prominent engineer in one of the leading Diesel publications.

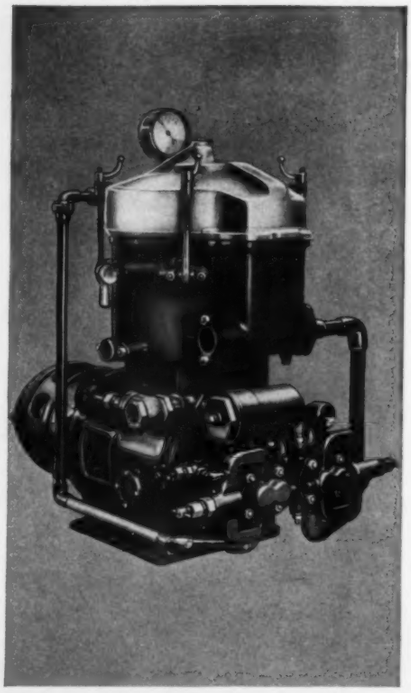
GOULDS HYDROIL CENTRIFUGAL PURIFIER REDUCES DIESEL ENGINE WEAR

"Whizzer" Proves Hydroilized Oil Is Clean

Goulds Hydroil Centrifugal Purifiers restore oil to a condition equivalent to new, protect Diesel engine life, and greatly reduce maintenance costs on long run operations.

Engine wear, and particularly cylinder liner wear, caused by abrasive matter, ash content, or liquid impurities in fuel oil, greatly reduce Diesel engine capacity and life.

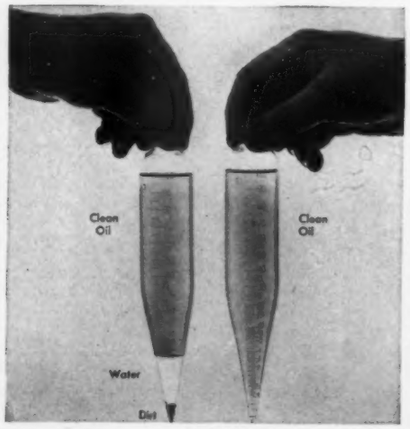
In a Goulds Hydroil Centrifugal Purifier, high speed rotation builds up a centrifugal force thousands of times greater than gravity, cleaning oil by throwing out dirt, water and sludge. The removal of all harmful abrasives and liquid impurities by frequent centrifuging does away with inspection, costly overlay repair periods, and assures a free flow of clean, fresh oil at all times to all moving parts, which means longer Diesel engine life.



Goulds "Hydroil" Centrifugal Purifiers are adapted for continuous by-pass or intermittent purification service. Cut Diesel operating costs. Write for details.

The *"Whizzer" Proves Hydroilized Oil Is Clean

This unretouched photograph shows samples of used Diesel oil before (left) and after (right) purification in a Goulds Hydroil Centrifugal Purifier.



*A special high speed laboratory centrifuge for testing oil samples

GOULDS PUMPS Inc.
SENECA FALLS N. Y.
ATLANTA, BOSTON, CHICAGO, HOUSTON, NEW YORK, PHILADELPHIA, PITTSBURGH, TULSA. Representatives in all Principal Cities

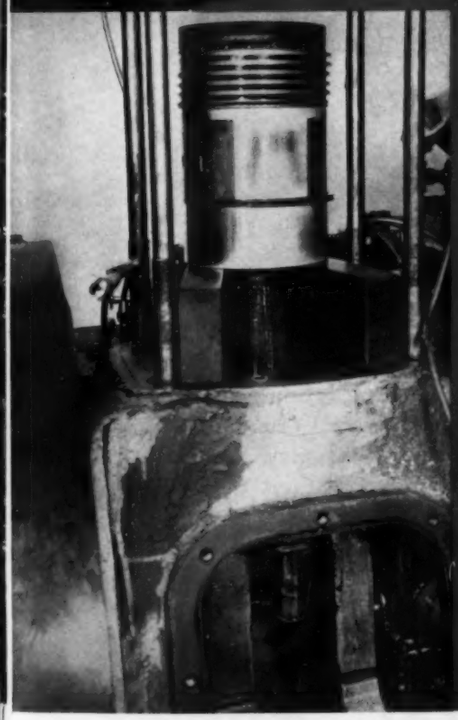
I'm SLUDGE *the menace*

I rob oil of lubricating value, wear bearings and compressors, score pistons and plug oil lines. No moving part is safe when I'm around and nothing will stop me but a Hydroil.

Copyright 1937, Goulds Pumps, Inc.

7041

For TEN times more Diesel Service Hours- SINCLAIR TEN-OL



Would you like to operate your "Caterpillar" Diesel engines ten times longer between shutdowns, without stuck piston rings or heavy wear on cylinder liners? Then use Ten-ol, the *new* alloyed Diesel engine lubricant developed for "Caterpillar" Diesels by Sinclair.

Besides multiplying service hours between shutdowns by ten, Sinclair Ten-ol cuts your "Caterpillar" Diesel overhaul costs by 90%. Ten-ol is recommended by the Caterpillar Tractor Co. as a "new outstanding Diesel engine lubricant".

Order Sinclair Ten-ol, Sinclair Diesel Fuel and other Sinclair products from your local Sinclair office or write Sinclair Refining Company (Inc.), 630 Fifth Ave., New York City.

Sinclair Ten-ol lubricated this official "Caterpillar" Diesel test engine in a continuous 1093-hour accelerated wear test at the Sinclair Bureau of Standards. The above unretouched photograph shows engine taken down for inspection. Note perfect condition of rings and piston, and the cleanliness of the crankcase after draining. Compare with piston at right.

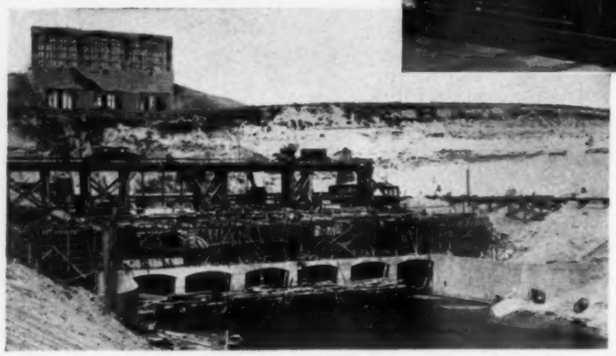
The finest grade of straight mineral oil was used to lubricate the above piston in a "Caterpillar" Diesel engine during a continuous acceleration test only 1/10 as long as the test described at left. Note in unretouched photo signs of blow-by indicating poor piston seal, carbon-coated piston crown, sludge, plugged oil control rings and gum on piston skirt.

15,000,000 Gallons of Water
Pumped Every 24 Hours for 6 Months by
INTERNATIONAL
Diesel Engines

Above: The sheds and derricks in this view indicate the location of four of the eight International Diesel engines on the site of the Columbus, Neb., power house.

At Right: One of the eight International Diesels used by the Thorpe Well Co., on this big pumping job.

Below: The Columbus power house and intake under construction.



Operating under full load continuously, pumping 15,000,000 gallons of water every 24 hours, 7 days a week, for 6 solid months — that's the part 8 International Diesel Power Units have had in the development of the Loup River hydro-electric project near Columbus, Neb.

A vital problem confronting the engineers in the construction of the power house consisted of disposing of the sub-surface water in a pit some 60 feet below the natural level of the valley and more than 40 feet below the water table, as well as maintaining a bed-rock water level during the period of excavation and construction.

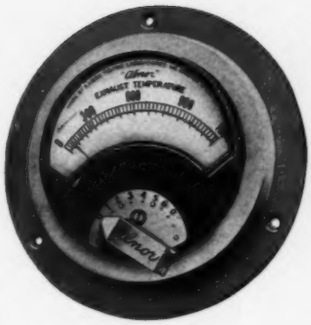
The contract for draining the power-house site was awarded to the Thorpe Well Co., Des Moines, Ia. Deep-well turbine pumps and 8 International Diesel Power Units to drive them were selected. This equipment was floated on barges until the water level in the pit was lowered so that platforms could be built on 30-foot pilings. Then eight 10-inch wells were sunk to bed rock, and engines and pumps installed in the pump houses.

Fuel consumption of the International engines averaged 60 gallons each, every 24 hours, during the first three months. Operations slowed down to some extent the next three months and the fuel consumption was reduced to an average of 43 gallons. *There was no cost for repair parts during the entire six months.*

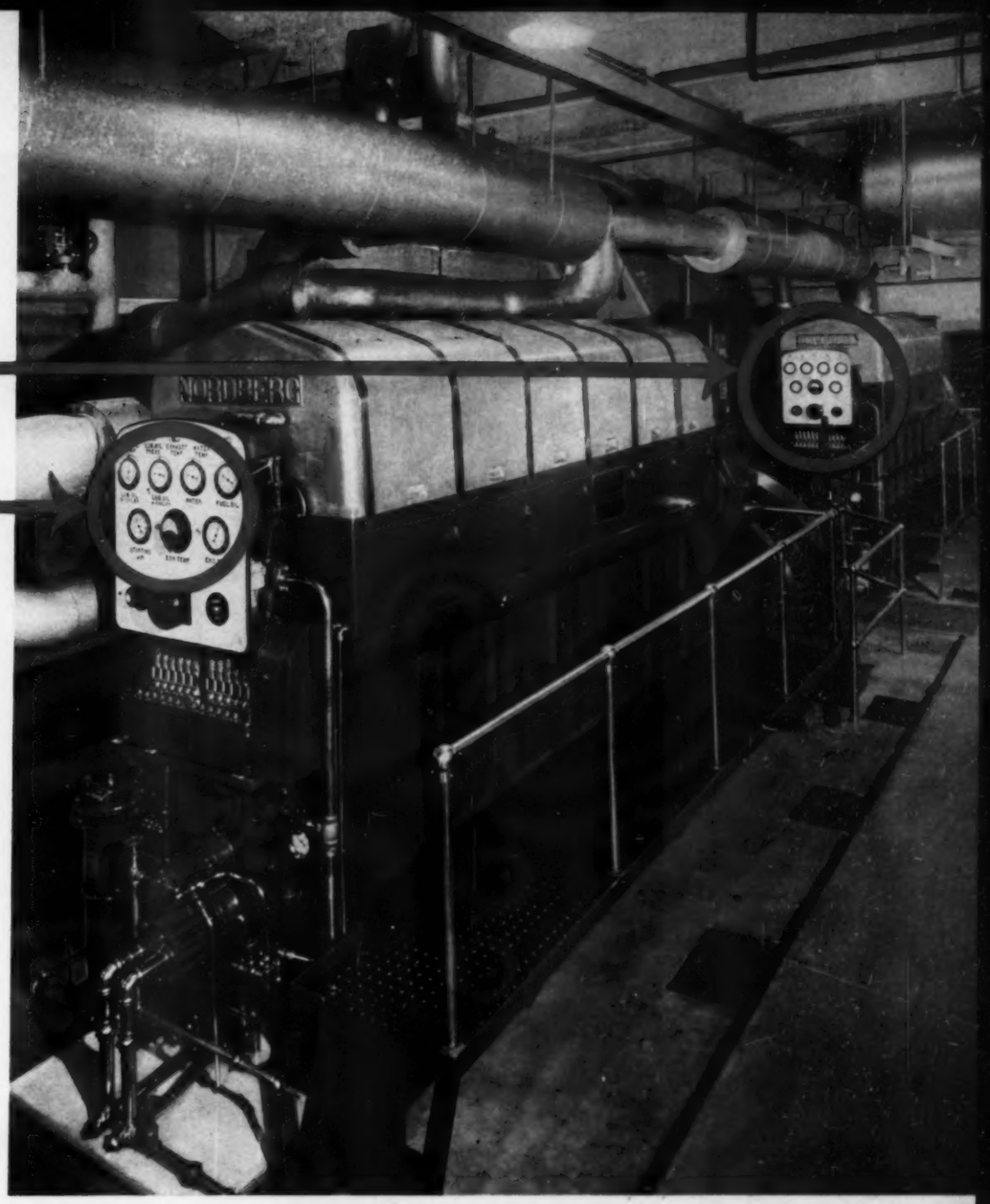
The record of these International Diesel engines is the soundest kind of evidence of their stamina and quality. Investigate International Diesels for your own work. The nearby Company-owned branch or industrial dealer will give you full information.

INTERNATIONAL HARVESTER COMPANY
(Incorporated)
606 So. Michigan Ave. Chicago, Illinois

INTERNATIONAL Industrial Power



Alnor Exhaust Pyrometer as Installed on the Two Nordberg Diesels at Sailors' Snug Harbor



Sailors' Snug Harbor Diesels Served by Alnor Pyrometers

● Sailors Snug Harbor is the first real Diesel "Block" plant to be operated in Manhattan to supply electricity to buildings of different types and sizes.

In this plant two 300 hp. 6 cylinder 10½ by 15 mechanical injection Nordberg Diesel engines are directly connected to two 250 K.V.A. generators.

The whole installation is arranged to make it as fool-proof and breakdown proof as possible.

A convenient panel is mounted on each engine which contains various indicating instruments, including an Alnor Exhaust Pyrometer to provide temperature readings of the exhaust from each cylinder.

This instrument panel is shown in the engine room view above. The Alnor multi-point Pyrometer round flush type is mounted in the center.

Alnor Exhaust Pyrometers are serving thousands of American Diesels as well as many abroad. There must be a reason.

Write for Details

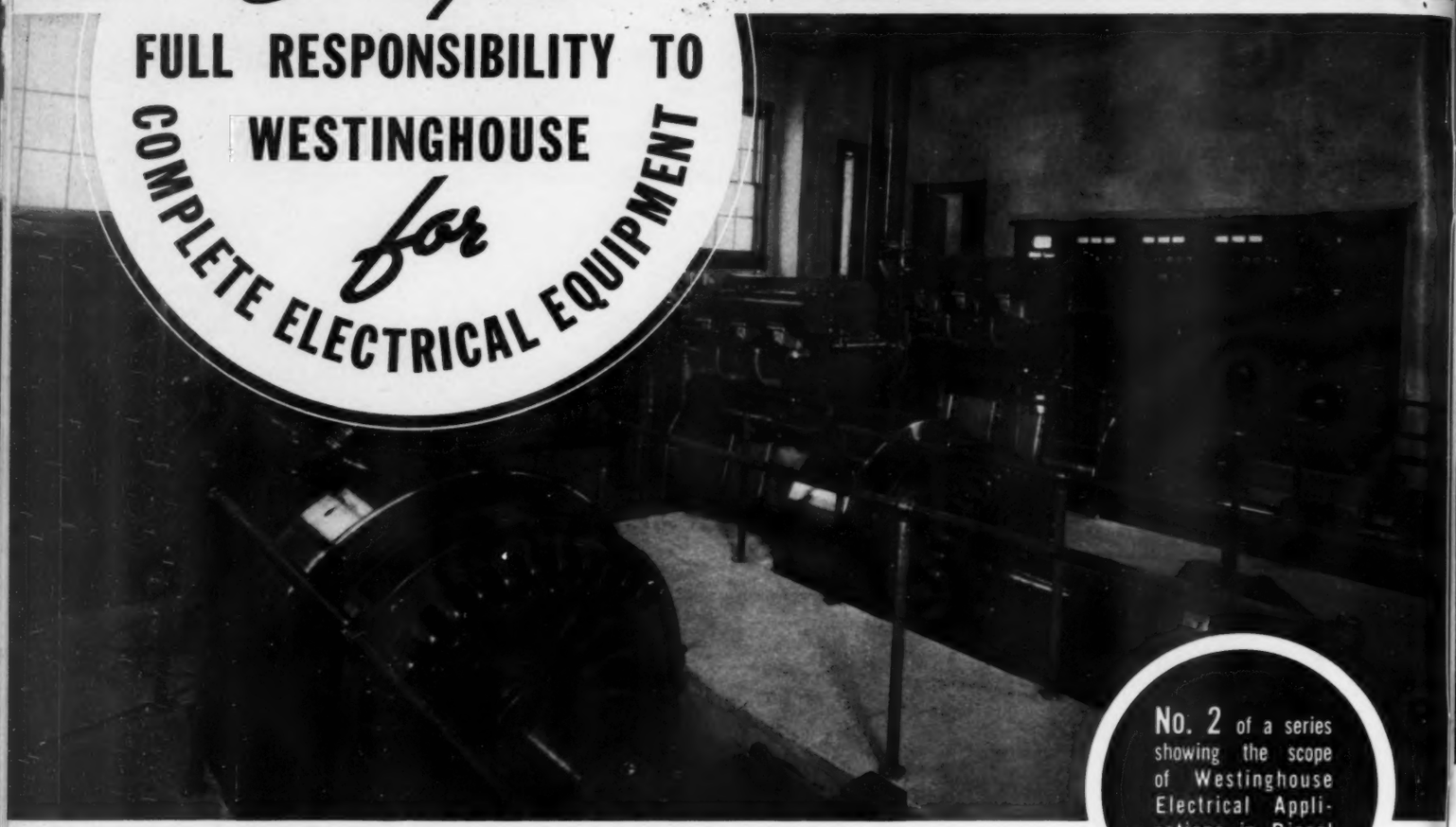
ILLINOIS TESTING LABORATORIES, Inc.
423 North LaSalle Street • Chicago, Illinois

Testing Engineers and Manufacturers of "Alnor" and "Price" Pyrometers.
The Products of 37 Years' Experience.

Use "Alnor" Pyrometers—*The Diesel X-Ray*

Delegate

FULL RESPONSIBILITY TO WESTINGHOUSE *for* COMPLETE ELECTRICAL EQUIPMENT



No. 2 of a series showing the scope of Westinghouse Electrical Applications in Diesel Power Plants.

ON STATEN ISLAND, NEW YORK . . . WESTINGHOUSE GENERATORS DRIVEN BY COOPER-BESSEMER DIESELS . . . to furnish power for lighting, radio broadcasting, refrigeration, pumping water, grinding feed, etc.

★ You can't go wrong when you delegate to Westinghouse full responsibility for the complete electrification of your Diesel Power Plant. By so doing you gain a double advantage:

(1) That of securing *matched equipment* . . . every electrical unit in the installation built to a single standard of quality; and

(2) That of insuring *a dependable follow-through* after the installation . . . which solves once and for all the problem of equipment maintenance.

Since the earliest days of the Diesel engine, Westinghouse has specialized in the production of generators and complete electrical auxiliaries to fit all types of Diesel Engine drives. Case studies of actual installation performance attest the success of this program . . . prove that when you delegate full responsibility to Westinghouse you can't go wrong!

J 10012

Specify

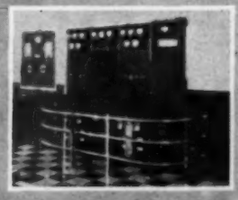
MATCHED ELECTRICAL EQUIPMENT

Westinghouse engine-driven generators and electrical auxiliaries, are manufactured to a single standard of quality for matched performance.

ES GENERATORS—Especially designed for lifetime operation in Diesel Service, with these extra values: *Solid Steel Rotor*, to withstand severest stresses under all conditions. *Protection against Shut-downs*, insured by exclusive high frequency pre-testing. *Positive Ventilation*, for cool running and long life.

EXCITERS—Either direct-connected or belt-driven, as required.

MOTORS—With dual-protected windings, rigid cast frames, and sealed-sleeve bearings . . . for driving compressors and other auxiliaries.



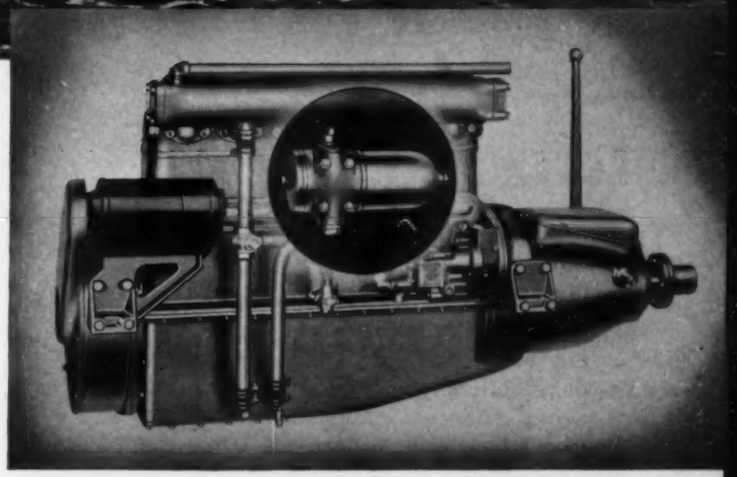
COMPLETE SWITCHBOARD ACCESSORIES—For every requirement: instruments, instrument transformers, relays, switchgear, circuit breakers.

Westinghouse

ENGINE-DRIVEN GENERATORS AND ELECTRICAL AUXILIARIES

A LITTLE BOAT GOES A LONG WAY

. . . with this Diesel



The "6-288" Kermath Diesel. A new, compact, 6-cylinder, 82 H. P. marine engine.

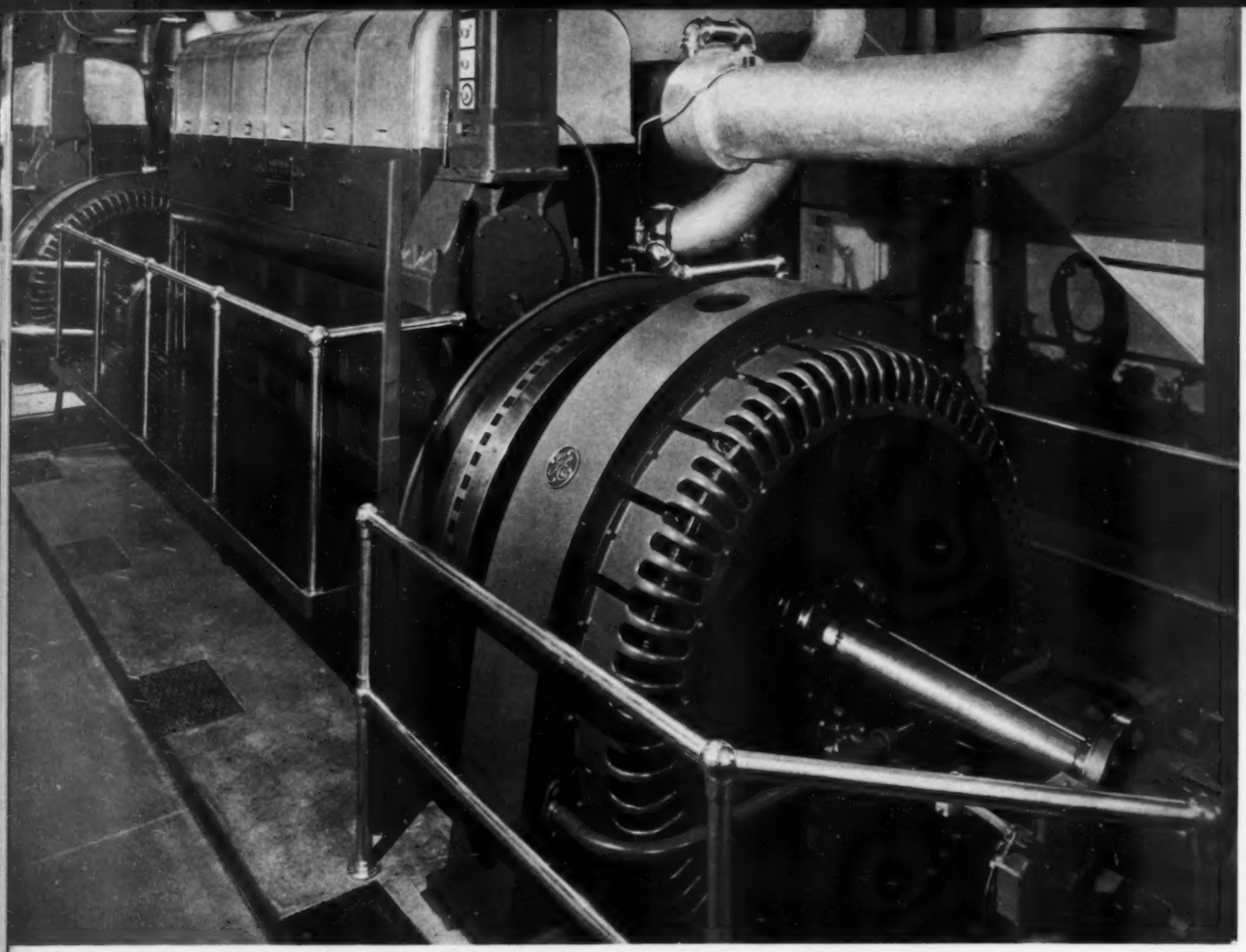
This 32-foot Baltzer-built cruiser is demonstrating that the long cruising radius, economy and safety inherent in Diesel marine power are now practical, efficient realities available to small boat owners.

The positive protection that PUROLATOR Oil Filters give both the fuel and lubricating systems of Kermath Diesels plays an important part in making such performance possible and dependable.

Each new development in the Diesel field presents designing problems peculiarly its own...and PUROLATOR engineers have made it *their* problem to meet manufacturers' requirements for perfect oil filter protection on every type of Diesel engine. We solicit your inquiries on any problem you may have in mind for either standard or special installations. Motor Improvements Inc., 365 Frelinghuysen Avenue, Newark, N. J., makers of

PUROLATOR

The Oil Filter



SAIL ORS SNUG HARBOR POWER PLANT

For Details read article on Page 26.

Left:
Started by Quincy Compressors are these two 300 H.P., six cylinder, 10½" x 15" Nordberg Diesel engines operating at 400 r.p.m. in the Sailors Snug Harbor plant in New York City.

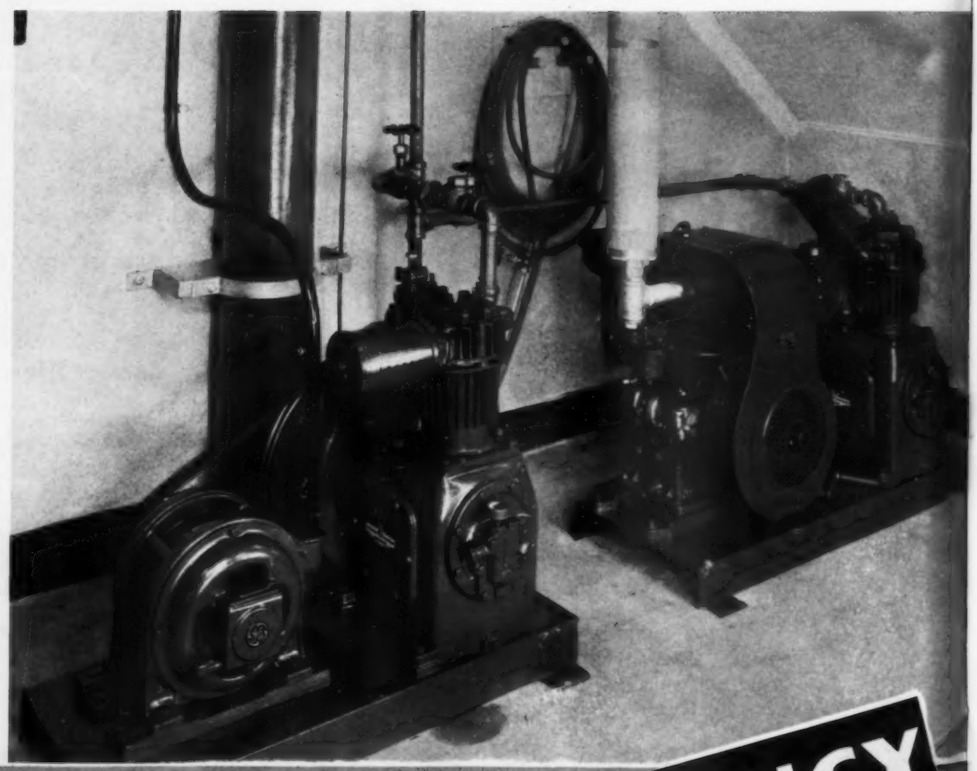
Below:
This pair of Quincy Compressors, one motor driven, the other operated by gasoline engine for standby service, insure positive Diesel engine starting in this modern power plant.

NORDBERG Diesel Starting Assured by QUINCY

BRILLIANT, low cost, steady light from the myriad of bulbs in an entire New York City block, and ample, non-failing, power for scores of electrically operated modern, labor saving and entertainment conveniences, that's the power assignment of the two 300 H.P. Nordberg Diesels in the recently completed Sailors Snug Harbor power plant at 255 Greene Street.

You'll find Quincy Compressors as the starting means on this as on many other distinguished new Diesel engine installations, a further recognition by engineers of the exceptional all round merit of these finer air compressors.

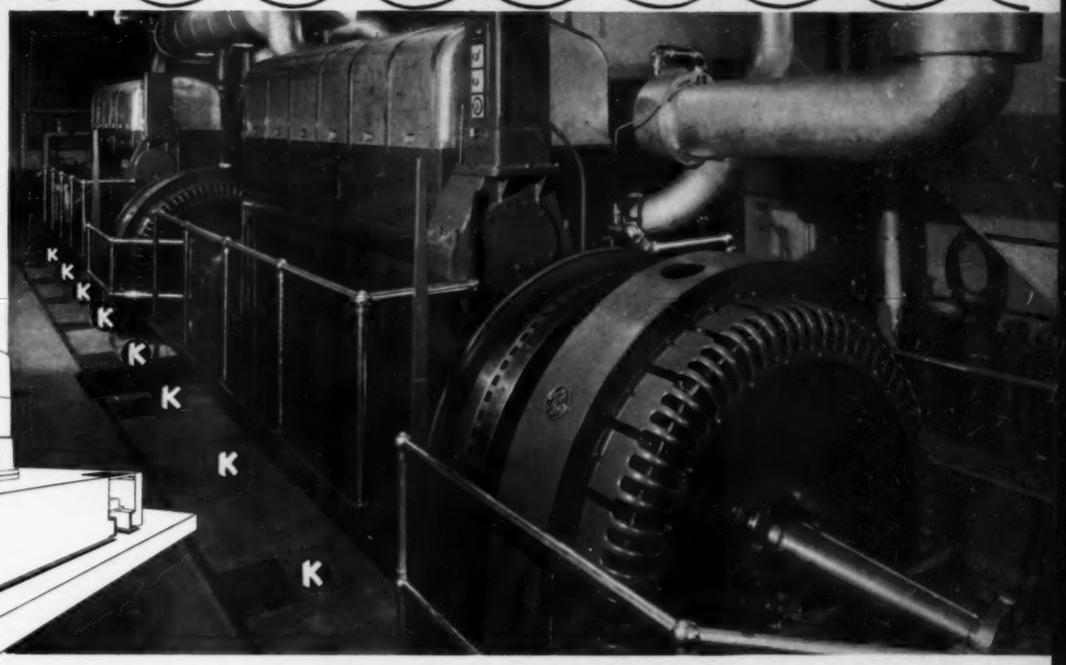
QUINCY COMPRESSOR CO.
QUINCY, ILL.
Branch Offices at New York and Chicago

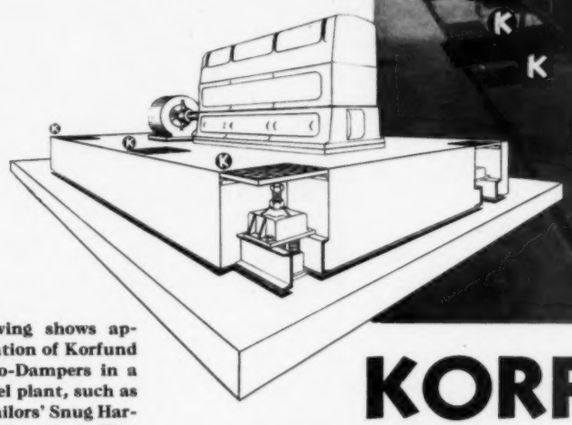


WHERE AIR IS IMPORTANT

Quincy Compressors

"All's snug in Snug Harbor!"





Drawing shows application of Korfund Vibro-Dampers in a Diesel plant, such as at Sailors' Snug Harbor, New York City, shown in photograph. "K" marks location of Vibro-Dampers, easily adjustable under removable cover plates.

Clyde R. Place Consulting Engineer. Curtis Electric Corporation, Operators.

KORFUND *Isolates* all Diesel Vibrations!

Neighbors live in peace and quiet around the Sailors' Snug Harbor power plant in Manhattan . . . the vibrations from the big Diesels have been permanently "isolated" by KORFUND.

In hundreds of hotels, schools, public buildings, industrial plants and aboard ship KORFUND Anti-Vibration Products are stifling Diesel vibrations *at their source!* Don't tolerate machinery vibrations which interfere with efficiency, lower production, cause annoyance and depreciate the value of buildings and equipment.

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When Atlas Diesels come in High Power Costs Go Out

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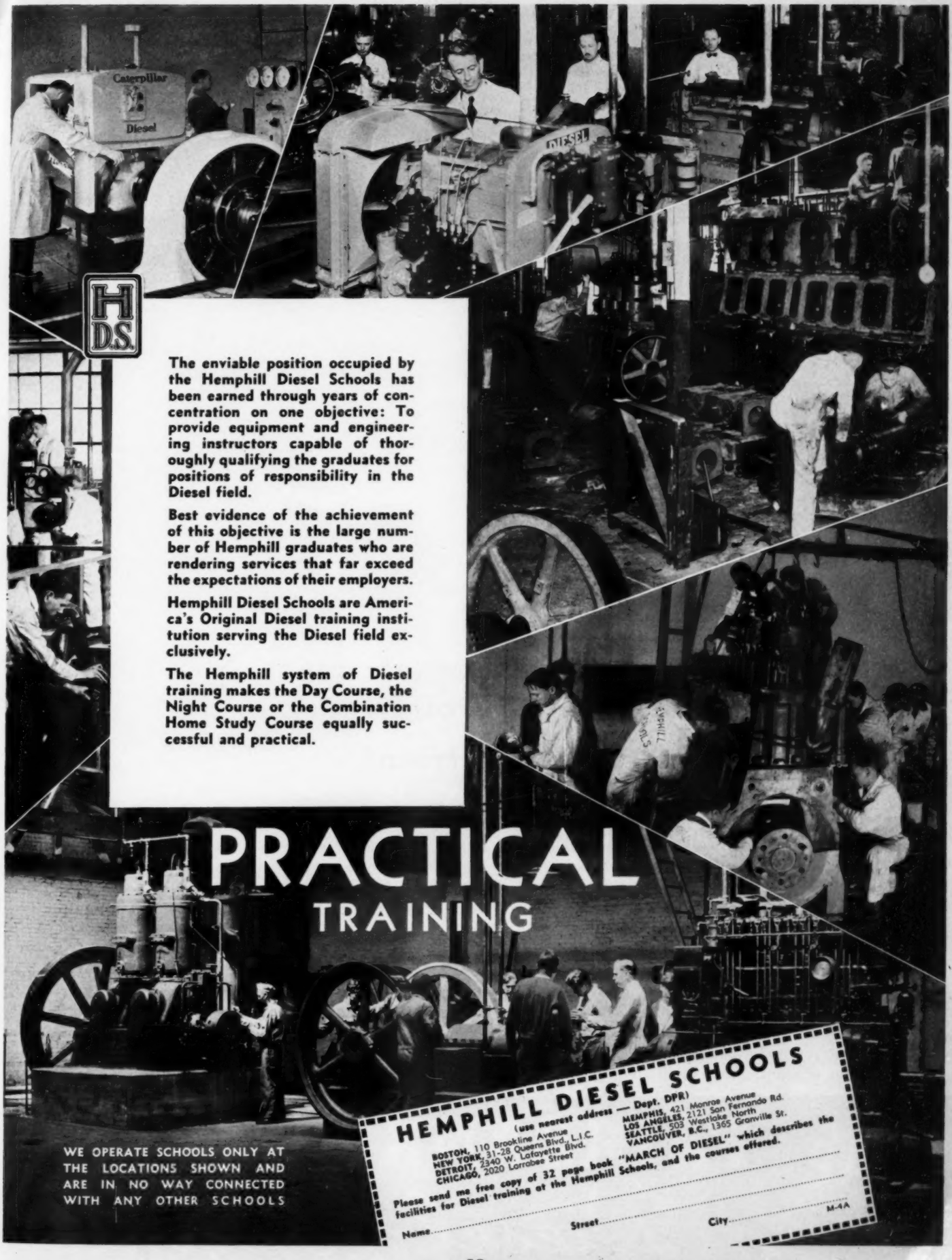

H D.S.

The enviable position occupied by the Hemphill Diesel Schools has been earned through years of concentration on one objective: To provide equipment and engineering instructors capable of thoroughly qualifying the graduates for positions of responsibility in the Diesel field.

Best evidence of the achievement of this objective is the large number of Hemphill graduates who are rendering services that far exceed the expectations of their employers.

Hemphill Diesel Schools are America's Original Diesel training institution serving the Diesel field exclusively.

The Hemphill system of Diesel training makes the Day Course, the Night Course or the Combination Home Study Course equally successful and practical.

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WE OPERATE SCHOOLS ONLY AT THE LOCATIONS SHOWN AND ARE IN NO WAY CONNECTED WITH ANY OTHER SCHOOLS

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Please send me free copy of 32 page book "MARCH OF DIESEL" which describes the facilities for Diesel training at the Hemphill Schools, and the courses offered.

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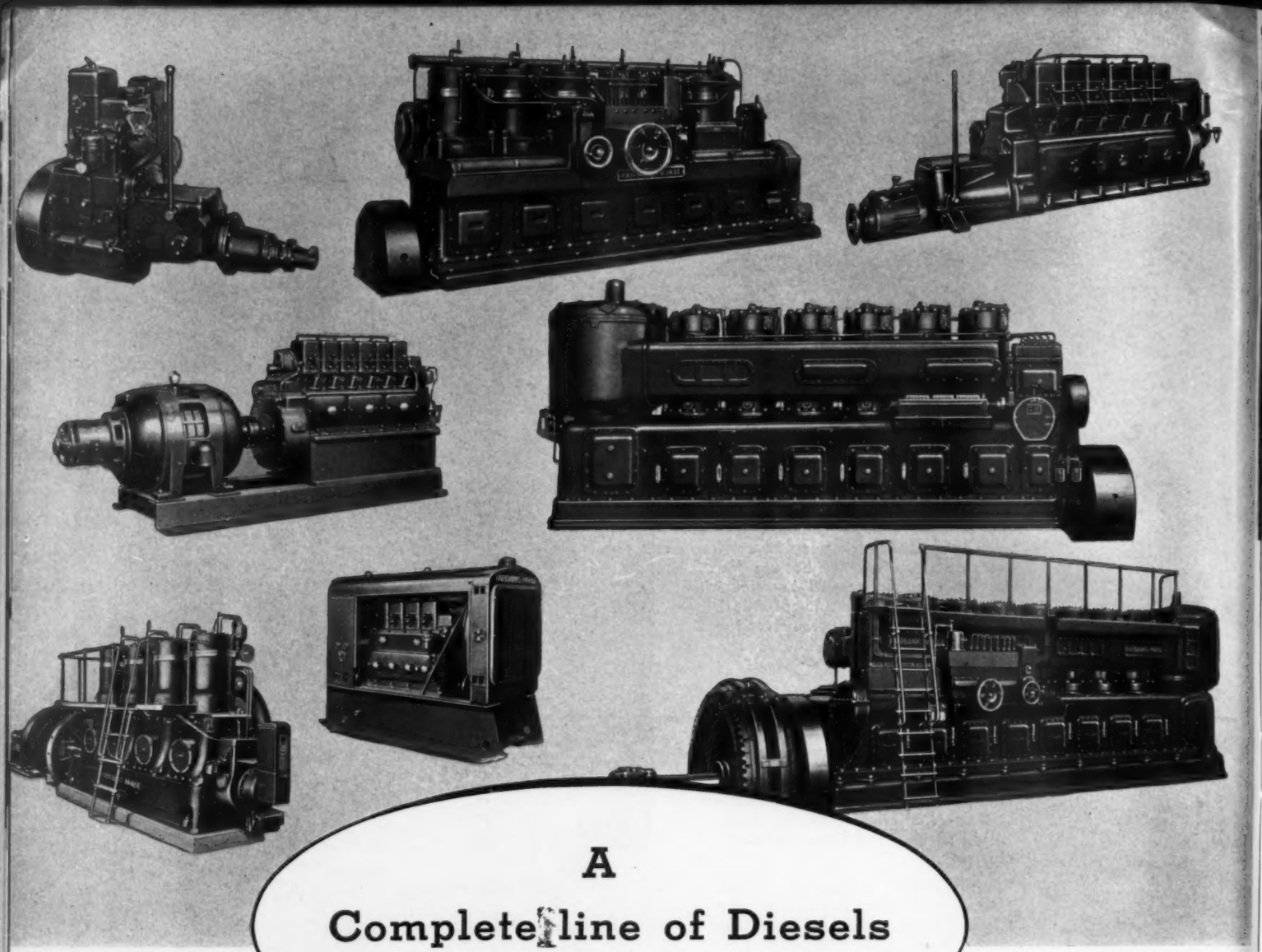

A Complete line of Diesels to choose from!

A COMPLETE line of Diesels to choose from—a model for every application . . . what that means to the prospective user of Diesel power!

It means that he can discuss his particular power application with a Fairbanks-Morse engineer and know that the Diesel recommended is not one which will be adapted to fit a specific need, but one which was designed and built to do the job. Only a manufacturer with a complete line can offer such a service. F-M stationary Diesels cover nearly every need of industry from compact, portable power units of 10 to 160 hp. up to giant, heavy duty Diesels to power a city. F-M Marine Diesels range from compact 10 hp. units for work-boat propulsion up to engines for the largest freighters. Auxiliaries supply current for battery charging and drive compressors and man the bilge pumps.

When you buy Diesel power, consider the extra advantages that only a manufacturer with a complete line has to offer. Then—call the man from Fairbanks-Morse. Write for Bulletin A.O.B.-200-23. Fairbanks, Morse & Co., 900 S. Wabash Avenue, Chicago, Ill. 34 branches at your service throughout the United States.

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106 YEARS OF PRECISION MANUFACTURING

FAIRBANKS-MORSE

Diesel Engines

POWER, PUMPING AND WEIGHING EQUIPMENT

DOES EVERY OIL FORM CARBON?

RING-FREE TEST No. 5* ANSWERS THAT QUESTION

(*One of a Series of Motor Oil Tests Pioneered by Macmillan)

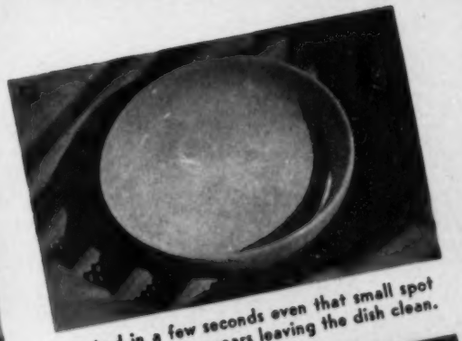
● Heat an evaporating dish to the temperature where two drops of a competitive oil will not spread but instead cook in a drop formation. Then, put two drops of the oil in the dish as shown and—

within a short time the competitive oil will cook down to a hard, black deposit of carbon in the bottom of the dish. This shows what happens to oil under the intense heat of cylinders and pistons during motor operation.

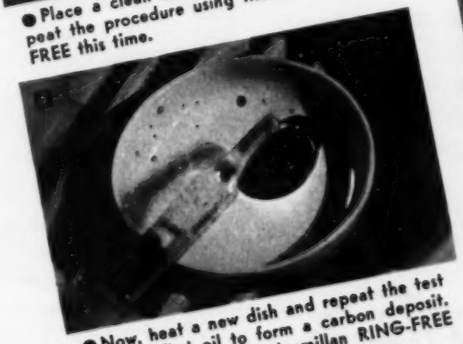
There have been many claims and counter claims about the carbon-forming habits of motor oils . . . so many conflicting claims that the average motor operator does not know what to believe. The astonishing test explained here will show you how to find out exactly how much carbon residue any oil forms and how Macmillan RING-FREE will remove that carbon.

● Place a clean dish on the heater and repeat the procedure using Macmillan RING-FREE this time.

● As Macmillan RING-FREE cooks down it leaves a small brown spot in the dish as shown in the photograph.



● And in a few seconds even that small spot completely disappears leaving the dish clean.



● Now, heat a new dish and repeat the test with the first oil to form a carbon deposit. Then put a drop of Macmillan RING-FREE on the carbon deposit.

● Soon after RING-FREE vaporizes the carbon will disappear from the area RING-FREE touched. Perfect proof that RING-FREE removes carbon.

● A variation—over the carbon deposit, a drop of the competitive oil placed on the left, a drop of RING-FREE on the right . . . with the result as shown above.

There is the answer! You will KNOW it is true after you run this test for yourself. The Macmillan Man in your town can supply the equipment . . . you supply the oil. Then, realize what it means in fewer motor overhauls and reduced maintenance costs to say nothing of the increased life of the motor and the elimination of carbon knocks.

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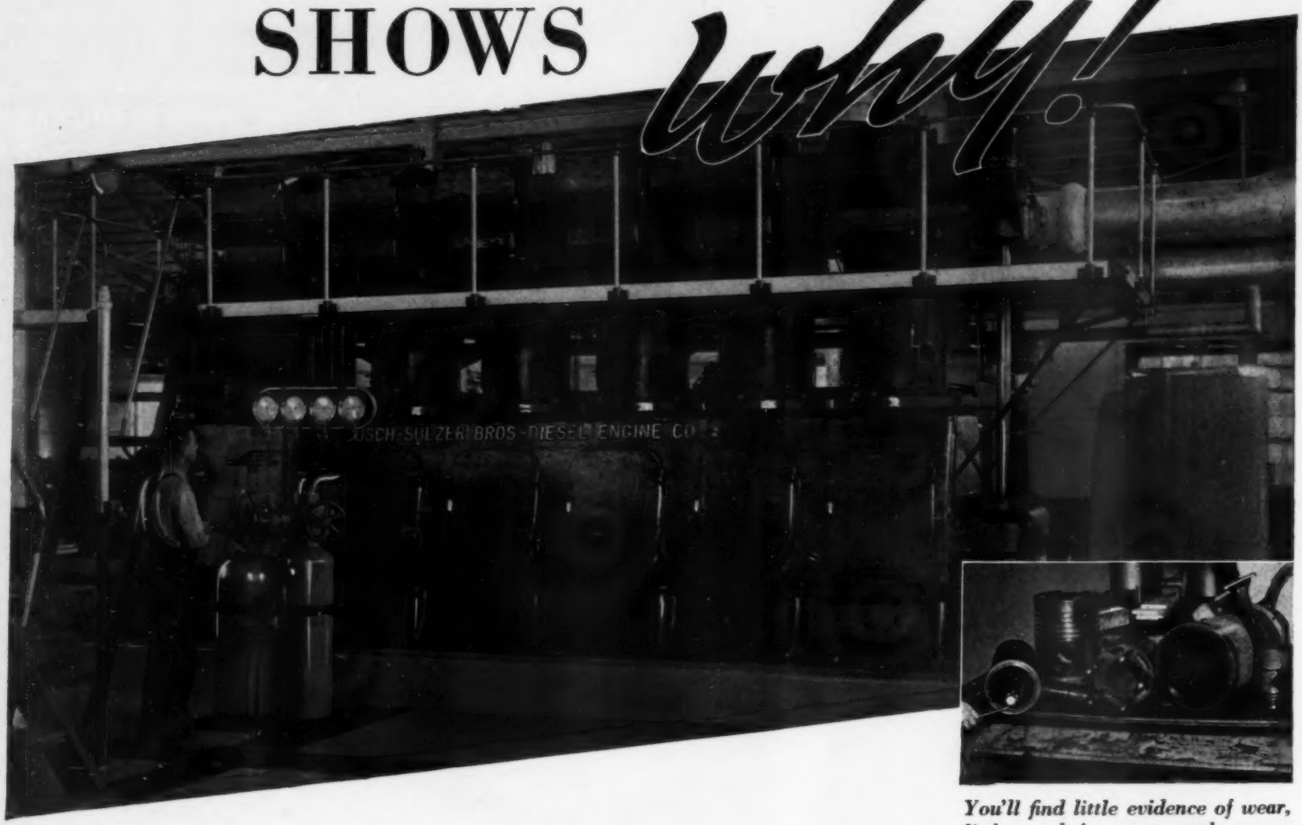
MACMILLAN

RING-FREE

MOTOR OIL

1. GREATER FILM STRENGTH
2. HIGHER HEAT RESISTANCE
3. LONGER CLING TO METAL
4. FASTER PENETRATION
5. REMOVES HARD CARBON
6. IS NOT CORROSIVE

THE FIRST INSPECTION SHOWS *why!*



You'll find little evidence of wear, little need for parts replacement when using Texaco Algol or Ursa Oils. These oils help substantially in keeping Diesels in their prime.

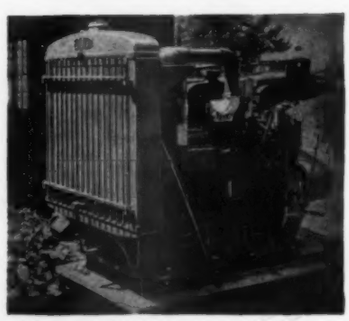
WHEN you tear down your Diesels, you'll find piston rings, valves, and ports that are clean, maintaining high compression that means fuel economy and low maintenance costs.

Texaco Algol and Ursa Oils are wholly distilled, and freed from the impurities which cause gummy deposits that burn into flint-hard carbon. What little carbon forms is dry, fluffy . . . blows away harmlessly.

Many Diesel cylinder oils break down under the intense heat, forming tar and gum that stick rings and valves and cause loss of compression, fuel waste, high maintenance costs. More Diesel h.p. is lubricated with Texaco throughout the United States than with any other brand.

Trained lubrication engineers are available for consultation on the selection and application of Texaco Petroleum Products. Prompt deliveries assured through 2020 warehouse plants throughout the United States.

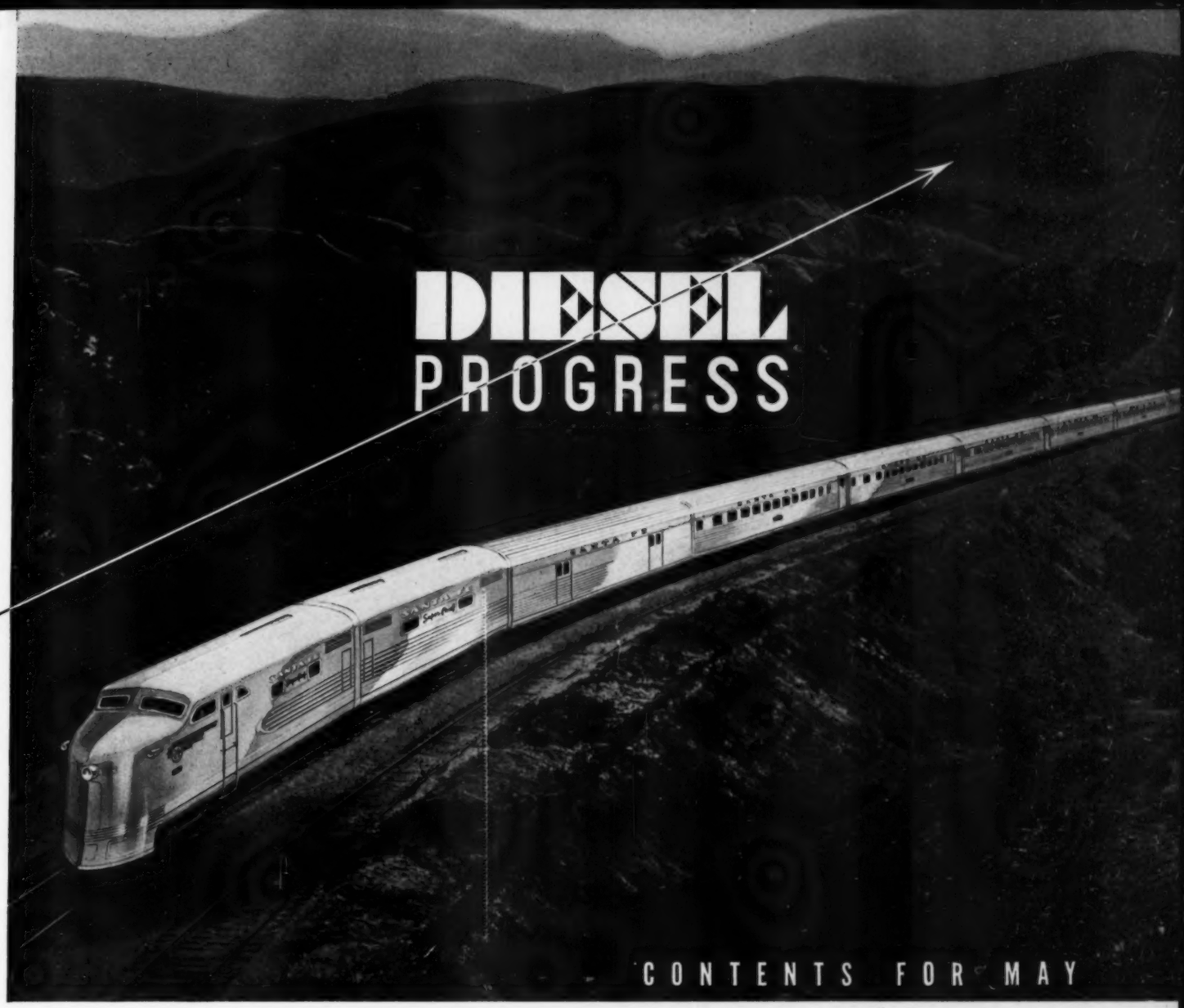
The Texas Company, 135 East 42nd Street, New York City.



Maintained efficiency and freedom from carbon troubles in smaller Diesels and portable units, often operating under less favorable conditions, is largely a question of lubrication. Texaco Oils will meet these conditions.

TEXACO

Lubricants for all types of Diesels



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DIESEL PROGRESS for May, 1937, Vol. III, No. 5. Published monthly by Diesel Engines, Inc., 2 West 45th St., New York, N. Y. Tel. MUrray Hill 2-5092.

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NO. 4 OF A SERIES

Trade School "Rookies"

Champions of Tomorrow

EACH YEAR in the field of sports, interest centers on a new batch of "rookies"; youngsters who are coming up in the ranks. Bob Feller, sensational rookie, making his debut in major league baseball, gives promise of providing this national pastime with a new champion, a new hero—who sport writers claim will outdo that old-time rookie and most famous of recent champions, Babe Ruth. Last year, Joe Di Maggio, rookie from the Pacific Coast, set the pace that gave the Yankees a World Championship. In every sport, yesterday's rookies are the champions of today.

In the professional world, the "rookies" of yesterday are the outstanding champions in the fields of law, of medicine, of science. World leaders in politics, in business, in every walk of life, were nothing more than "rookies" when they started up the ladder; youngsters who had something "on the ball"—and who quickly proved their worth when experience was added to their natural ability and the long period of preliminary training each rookie must complete.

There are thousands of rookies; but only a certain kind make champions. Seldom will there be a successful champion developed from one who lacked sound, thorough training in fundamentals, in basic principles, and in the finer details.

The future champions in the mechanical occupations of Industry, in Diesel as in other trades, will be from among those "rookies" who enter the field with the proper foundation; with the right kind of sound, basic fundamental and practical training. The function of the properly operated, efficient trade school is to take the "rookie" as raw material, and provide him with the training he needs. Such "rookies", representing a group of energetic young men, with natural mechanical ability, ambitious, willing to study hard, definitely interested in the work they have chosen for themselves — provide ideal material from which to choose the workmen needed for the specialized, technical jobs that must be filled in the rapidly growing Diesel Industry.

•

In your need for such men we are pleased to make available their services with our fullest recommendation. National Schools is endeavoring to place with the Diesel Industry young men who have been carefully trained by the most practical methods. National Schools was established in Los Angeles in 1905 and has continued without interruption under the management of its fouders, with a definite policy of honesty, sincerity and worthiness of purpose. Today, National Schools, representing a million-dollar investment, offer sound, thorough instruction courses in Diesel and Gas Engine work and Radio and Electricity.

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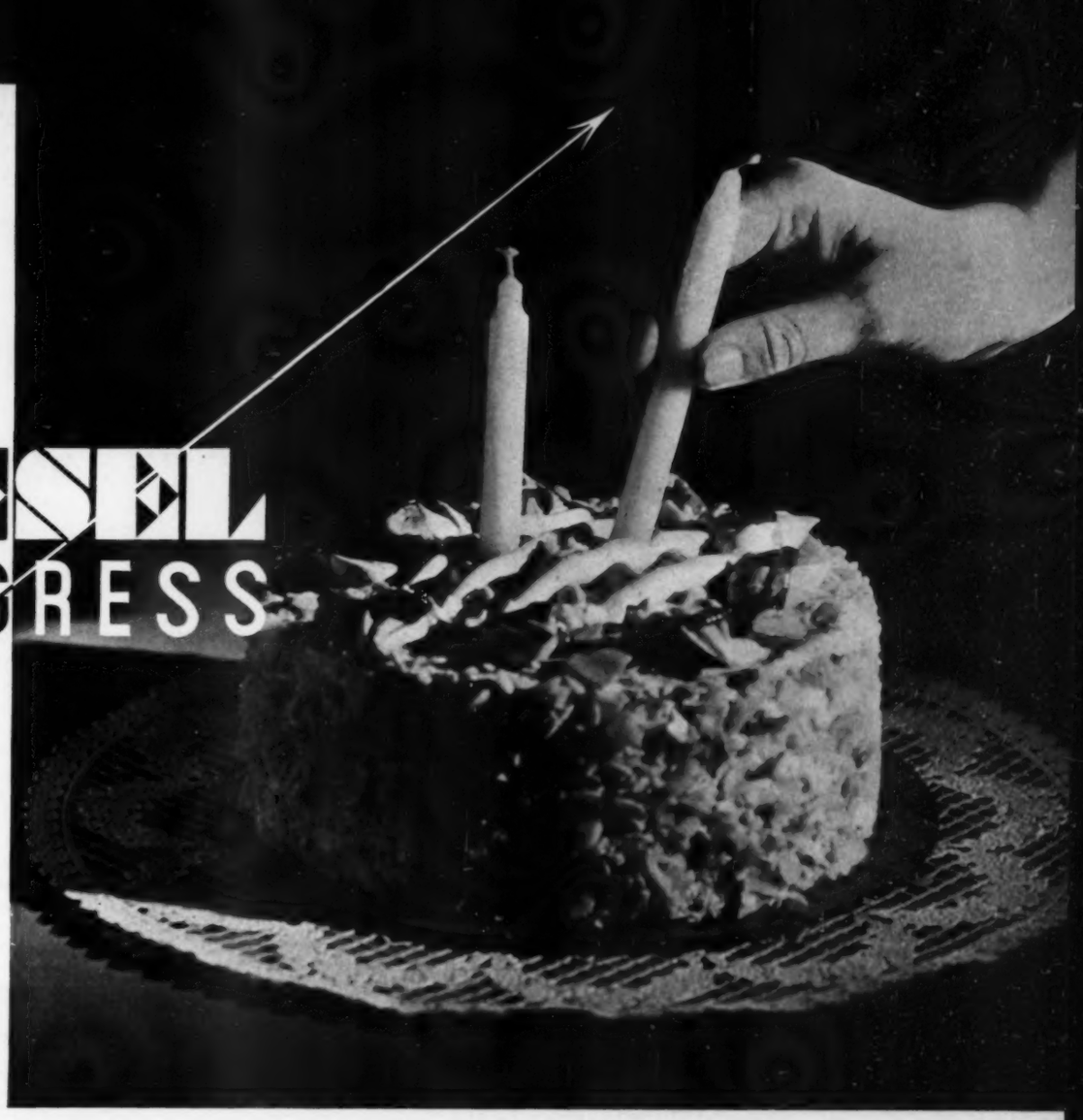
DIESEL PROGRESS

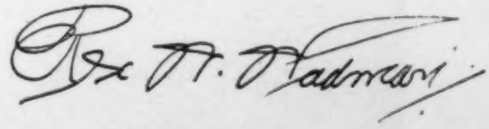


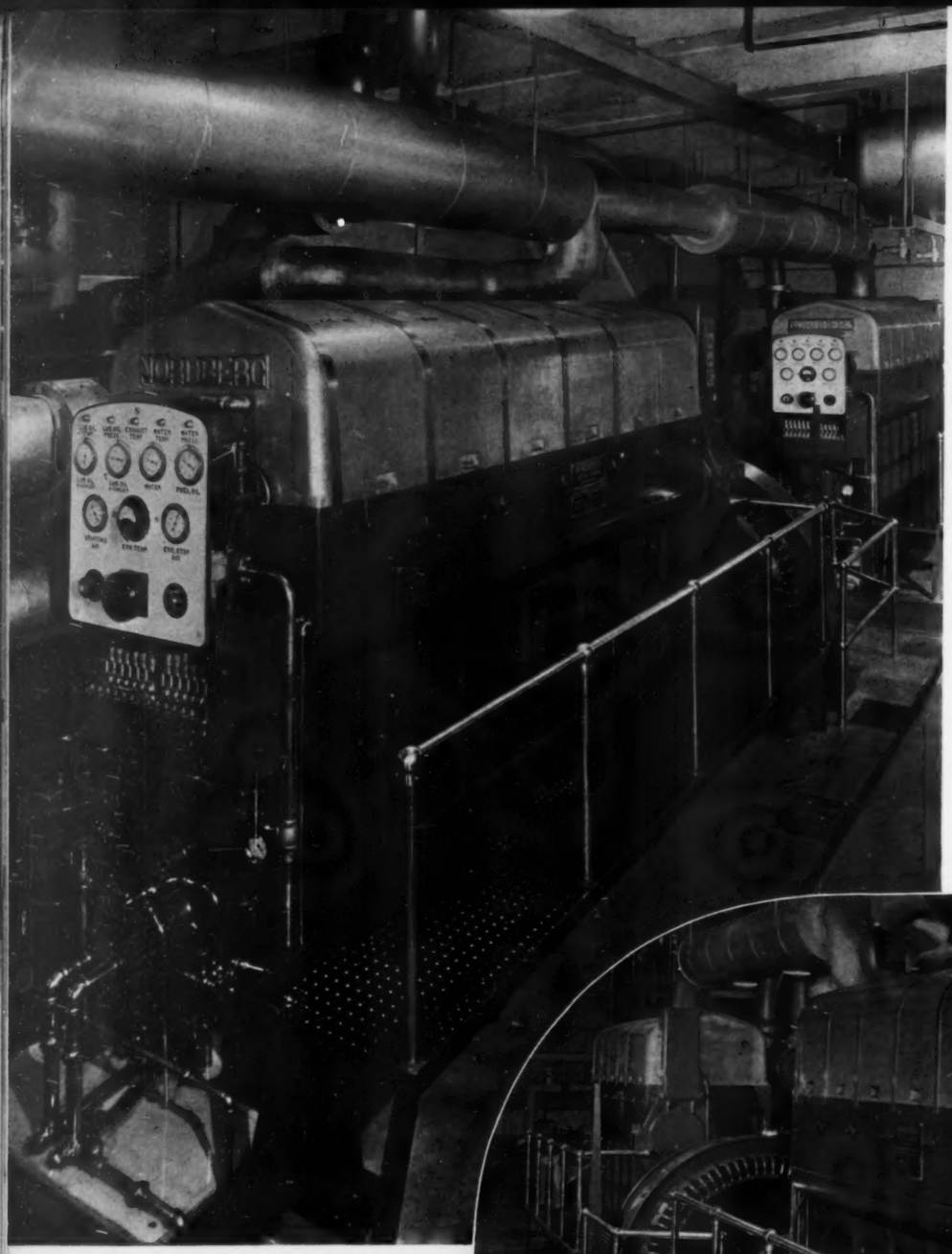
NEW YORK CITY, April 20th, 1937. Just two years ago today we put the first issue of DIESEL PROGRESS to press. It was my own birthday then, as it is today. I was forty-eight back there in 1935. I'm fifty today. These last two years have been the most eventful, the most interesting and the most trying years of my life, but I've enjoyed every minute of the time.

To start a new business at any time is hazardous. To start a new business at forty-eight is extra hazardous. To start a new magazine in an already crowded field is almost suicide. But I did it, against the advice of most of my friends, because I had an idea, a plan, a dream and I've woven that dream into the "warp and woof" which is DIESEL PROGRESS today. The pattern has changed since the first issue. It will continue to change as my readers ask it to be changed. But the texture, the basic cloth, is still there — the original dream brought into reality, carried through to a triumphal conclusion of two years of successful operation and out into a new year of ever-widening acceptance, of ever-widening power in its ability to *sell the Diesel Idea* to more and more people.

That was my dream back there in 1935 — to produce a new, a different, and much better magazine whose sole purpose in life would be to sell more Diesel engines to more people — many more people.

And on this, our second birthday, and my fiftieth, I feel my work has not been in vain, that we are on our way because we have done and are doing a good job and you, my readers and advertisers, have appreciated that fact, have encouraged us, helped us and made it possible for me to say "thank you" from the bottom of my heart for putting DIESEL PROGRESS right where it is today, away out in front and stepping free.





The instrument panels of the Nordberg Diesels carry complete Viking Safety Controls and an Alnor pyrometer for each engine. Directly beneath is the Manzell lubricator and below that the Nugent fuel and lubricating oil filters.

The elimination of the transmission of vibrations was accomplished by means of steel spring units known as the Korfund Vibro-Dampers.

These Vibro-Dampers consist, essentially, of steel springs embedded in the concrete foundation and resting on the substructure. They form the only contact between the foundation proper and the rest of the building. The foundation thus "floats" on the springs which take up the vibrations and prevent them from being transmitted.

SAILORS' S

By JOHN W. ANDERSON

WAY back in 1801, there lived one Captain Richard Randall, a retired privateer, who pondered what should become of his money when he died. He called in a rising young attorney named Alexander Hamilton to draw up his last will and testament, and it was Hamilton who suggested the idea and the name for Sailors' Snug Harbor. He left his farm of some twenty acres, located at what was then the northern edge of New York City and bordering on the old Post Road, now Fourth Avenue, as a home for retired sailors who were unable to support themselves. Captain Randall died soon afterward and his relatives started litigation to break the will, but Hamilton proved his ability as a lawyer by the fact that the will was not broken then and the institution is still operating successfully under its original provisions. Just one change has been the enlargement of its provisions by a special act of the state legislature admitting all classes of sea-

RS' SNUG HARBOR

going men (there were no sea-going engineers in Captain Randall's day).

But due to the litigation the home was not actually founded until 1829, and by that time New York had grown to the point where it did not seem advisable to locate the home on the farm left for the purpose. Thus land was purchased and the home located on Staten Island, where it is today. But the original farm (assessed at $21,000 in 1801) was located roughly within the present boundaries of Fourth and Fifth Avenues and between the Arch and 10th Street, covering nine city blocks. This land can never be sold, and all the buildings in that area, including apartment houses, stores, hotels and dwellings, must lease the land. Such well known institutions as Wanamaker's, Hotel Brevoort, Hotel Lafayette, No. 1 Fifth Avenue and Washington Square North are within this area. This property today produces a net revenue of about $1,000,00 per year, and is one charitable institution which has never appealed to the public for funds.

But this article is concerned more particularly with the block bounded by Waverly Place and 8th Street, and by Greene Street and University Place. Within this block there is a 23-story apartment house containing 325 apartments, three loft buildings, a large cafeteria, several stores, a few dwellings, and there is a 600-seat movie house going in. Until recently the electric energy required has come from Edison, but now there is a Diesel plant located within the block and fronting on Greene Street which is taking the electric load. This plant was conceived, financed, constructed, and is now operated for Sailors' Snug Harbor by the Curtis Electric Corporation, who have been for many years the distributors of electric energy in the entire property.

As indicated by the plan of the plant, it is located in a new building built especially for the purpose and made to suit the land and space most readily available. The building is only one story high above the street level and the machinery is placed in the basement of the building. The street floor serves as a store room for the owners and also houses some of the engine equipment as will be discussed later. Access to the basement is by stairs at each end of the room, and the machinery was brought in through the large double street door and lowered through the hatch, shown on the plan, to the basement. The Diesel engines were taken in as complete units.

This plant is an excellent illustration of the adaptability of the Diesel engine. The engines and their auxiliary equipment were located to fit the space and, although the engine room is only 25 feet wide, there is a sense of roominess. This is helped by hanging the tanks from the ceiling and by placing the auxiliary equipment against the wall in out of the way places and on the floor above.

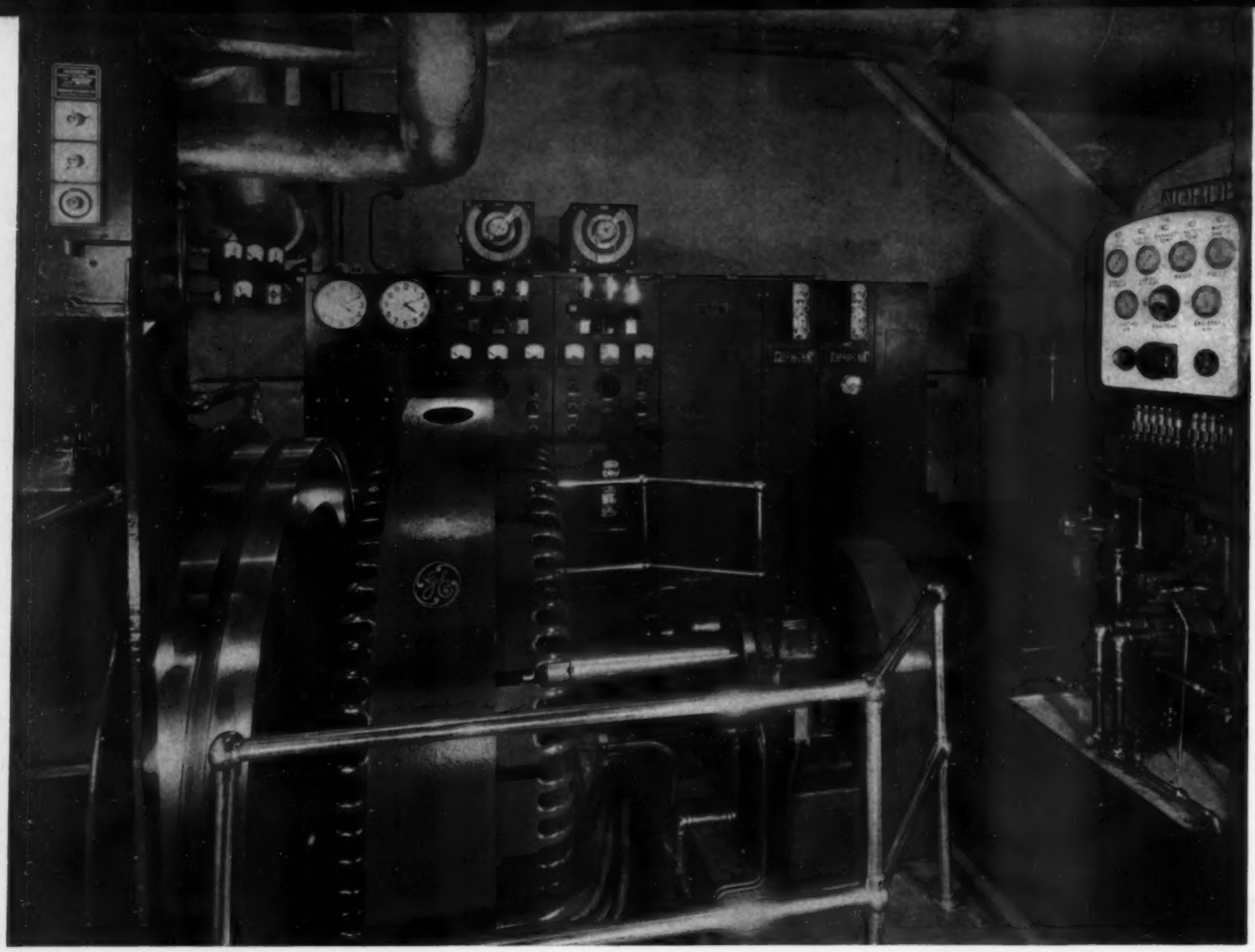
The Diesel engines are standard Nordberg six cylinder, four cycle, solid injection type, with cylinders 10½" by 15" and rated at 300 horsepower at 400 rpm. They are directly connected to 250 kwa., 200 kw. General Electric generators and 7½ kw. 1,750 rpm. V-belt driven exciters. These generators are 60 cycle, three phase, four wire, 216/124 volt machines. The engines are fitted with Woodward governors, and the generators with the latest type of General Electric voltage regulators. Each cylinder of each engine carries a Motoco thermometer.

The overall result is to obtain exceedingly close frequency and voltage control. All electrical loads, from lights to elevators, are carried directly on the generators, yet with sudden load swings of as much as 75 kw., which at times is 100 per cent of the base load, there is no noticeable flickering of the lights, and the momentary frequency change is less than half a cycle. The power factor is unusually high. In spite of neon signs, elevators and other motors there are enough lights on the circuits to keep the power factor close to 90 per cent.

At present there are only two engines installed, but it is anticipated that the third will be required shortly. Due to the diversified character of the load, it is expected that the load factor will approach 50 per cent. The manufacturing lofts give a good day load, the movie house will open at noon, the cafeteria is always open and the apartment house gives a high lighting load in the evening and a good average load at all times.

Each engine unit rests on its own individual foundation and sub-foundation. The soil conditions were unfavorable. Directly under the two-foot concrete sub-foundation there is a five-foot layer of clay resting on loose flowing sand. Fortunately there is no water in the sand. The sub-foundation was spread out as much as pos-

Starting air is supplied by these two Quincy compressors, one motor driven and the other connected to an emergency gasoline engine.



View of the General Electric switchboard and one of the generators looking between the two Diesels. Note the Woodward governor at upper left.

sible to reduce the bearing load per square foot to the minimum. Then the engine and generator with the foundation block under them are carried on the sub-foundation by the Korfund Vibro dampeners. There is a very slight tremor perceptible when standing on the engine foundation, but there is none whatever discernable on the engine room floor or in the building.

Intake air for the engines enters either through the roof from out of doors or from the store room space at the street level into the special room housing the Air Maze intake filter. This filter opens to a boxlike compartment from which lead the air intake pipes to the individual engines. There is a hinged cover over each of these intake pipe openings, and the position of it is controlled by a small wire cable from the engine room floor. When an engine is not running, the pipe is closed to prevent the engine in operation from drawing air in through the other engine instead of through the filter. Each engine has a Burgess silencer in the piping and located close to the ceiling alongside of the engine.

The exhaust is out through the Maxim silencers as shown on the plan, and through the engine room wall to one of the boilers used for heating the apartment house. The gases can be bypassed directly into the boiler uptake flue and to the stack, or they can be sent through the boiler to make as much steam as the exhaust heat will generate. There are two other boilers, oil-fired, which discharge their gases into this uptake and chimney. The latter extends to the top of the apartment house, 312 feet above, so that there is never a lack of draft. The exhaust is not audible at the top of the stack. All of the exhaust piping is lagged.

Fuel is delivered by trucks into the 6,000 gallon tank located under the sidewalk. This tank is really two 3,000 gallon tanks because of a division plate in the middle of the length. Special Socony No. 2 Diesel fuel is used. There are two Crosby gauges in the engine room for showing the amount of fuel in each compartment at any time.

There are two fuel transfer pumps, a motor driven Goulds rotary and a Viking hand pump. Either of them is used to pump the fuel from the storage through the Sentinel filter and the Neptune fuel meters to the day tanks. There is one meter and one 200 gallon day tank fitted with a Crosby gauge for each engine. By checking readings of the Neptune fuel meters against the hours of operation and kw. produced by their respective Diesels, it is possible for the engineers to maintain a constant and accurate check on fuel economy of each unit as well as on the plant as a whole.

From the day tank, the fuel flows to the engine driven supply pump, which delivers through another filter to the supply header for the Bosch injection pumps. Surplus fuel flows from the far end of this header back to the day tank. The position of the day tank on the wall provides a head of about 10 pounds on the injection pump suctions so that they are positively filled at every stroke.

These engines have an overspeed stop which is unique and interesting. Located next to the outboard bearing of the generator is the Strong overspeed trip mechanism. This actuates an air valve which admits air under some 35 pounds pressure to the fuel supply header for the injection pumps. There is an air inlet for each of the individual injection pumps, so that when the stop acts, the fuel is blown from the supply line immediately adjacent to the pump for each cylinder out through the return line to the day tank. With such a complete and quick clearing of fuel supply the engine stops promptly.

The engines have a pressure lubricating oil system which takes care of every bearing and part of the engine which requires lubrication. This system is entirely self contained on the engine. The bedplate is used as a sump and

the rotary pressure pump, located on the outside of the engine at the end and driven from the crankshaft, takes its suction from the sump and delivers through the Nugent filter and the Schutte Koerting cooler attached to the engine, to the bearings. There is a Manzel lubricator for the cylinders. In the corner of the engine room there is the Hydroil centrifugal purifier. It is the present practice to centrifuge the oil from each engine after every 24 hours of operation.

The jacket cooling water flows on a closed system. On the street floor are two motor driven Lecourtenay centrifugal circulating water pumps and the Patterson Kelly copper lined steel surge tank. Either of these pumps is of ample capacity to circulate the water needed for three engines. These pumps have only the friction head to overcome and their location avoids placing them under much static head. The heat from the jackets is recovered in the Griscom Russell heat exchanger (located overhead alongside of the third engine as shown in the plan view) through which is circulated city water on its way to the apartment house domestic hot water supply tanks. City water flowing from the tower tank 23 stories above is heated from about 60 to 120 degrees, while the jacket water is cooled from about 130 to 120 degrees.

The flow of jacket water is then from the surge tank to the circulating pump, to the engines, through the heat exchanger, and back to the surge tank. There are valves on the engines for controlling the water flow through the individual cylinder jackets, and dial type thermometers on the outlet from each cylinder. Cold city water is used to cool the lubricating oil, and the outlet from the oil cooler jacket is into the engine jacket system. This supplies makeup feed and any surplus overflows to the sewer from the surge tank. City water is also connected directly into the jacket cooling system through a reducing valve, so that in case the engine outlet temperature exceeds 140 degrees, cold water from the tower tank flows into the cooling system automatically and the high water temperature alarm on the engine is sounded.

In case the engine jackets are drained, or if any water accidentally collects on the engine room floor, it all flows to the sump with a motor driven pump under the float control.

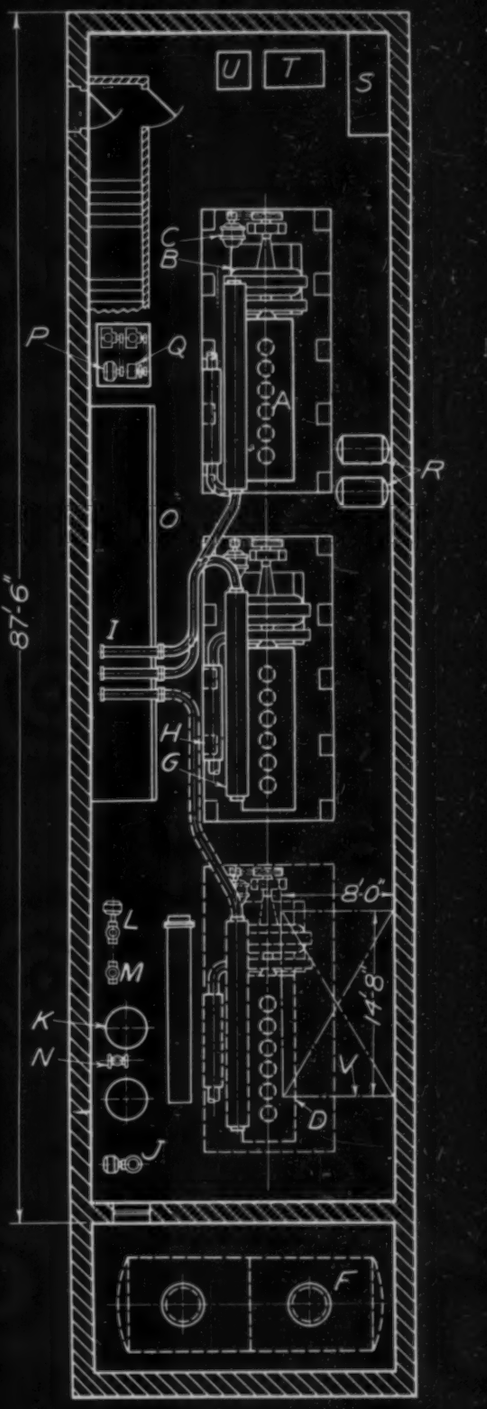
Starting is by compressed air supplied from the starting tanks which are suspended from the ceiling as shown on the plan. These tanks are charged by either the motor driven or the gasoline engine driven Quincy compressors. From these tanks through the reducing valve is taken the air supply for the overspeed stop. Then there is another reducing valve beyond that for getting the air pressure down to 15 pound pressure for use in cleaning the fuel filter and for other similar purposes.

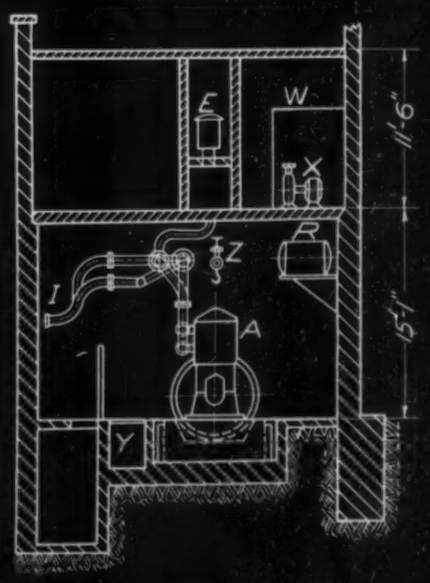
Each engine has a gauge board at the end. In addition to the usual fuel, lubricating oil, water, and starting air pressure gauges, there is also an emergency stop air pressure gauge, an Alnor pyrometer with a connection from the exhaust from each cylinder, and there is an alarm system. Low circulating water pressure, high circulating water temperature, low lubricating oil pressure, high lubricating oil temperature, or high exhaust temperature from the engine rings an alarm gong and indicates which item is at fault by a light. With this Viking safety system, normally all of the lights are lighted, and the one which goes out indicates the circuit at fault. There are test switches for testing each of the circuits at any time.

The station is equipped for convenient operation and maintenance work. There is every item needed for all of the usual work such as a large vise, spray valve testing equipment, motor driven grinder, and a full set of tools. Over the engines and running the entire length of the room there is the I beam and trolley for handling the engine parts. The Yale and Towne hoists are of 2 tons capacity and will handle all of the engine parts except the bedplate.

Every pipe line to and from the engine has a section of flexible United Metal hose in it to avoid any possibility of vibration transmission, and the exhaust lines also have a second section between the silencers and the pipe lines which extend to the apartment house boiler. Exhaust lines are supported by spring hangers.

The Curtis Electric Corporation were their own general contractors. Clyde R. Place was the Consulting Engineer who designed the plant and the architects for the building were Corbett and MacMurray. Roland Tompkins and Son installed the piping.





Legend

A—300 hp. at 400 rpm. Nordberg Diesel engine.
B—250 kva. General Electric alternator.
C—7½ kw. exciter.
D—Future generator unit.
E—Air intake chamber and filter.
F—Fuel storage tank.
G—Exhaust muffler.
H—Intake muffler.
I—Exhaust pipes.
J—Lubricating oil centrifugal purifier.
K—Fuel day tanks.
L—Motor driven fuel transfer pump.
M—Hand operated fuel transfer pump.
N—Sump and pump.
O—Switchboard.
P—Motor driven starting compressor.
Q—Gasoline engine driven starting compressor.
R—Starting air tanks.
S—Work bench.
T—Spare part and tool storage.
U—Engineer's desk.
V—Hatch in street floor.
W—Cooling water surge tank.
X—Motor driven circulating water pumps.
Y—Pipe trench.
Z—Trolley and hoist.

"SILVERHEELS"

MR. CHARLES A. CRIQUI, President of the Sterling Engine Company and Vice President of the National Association of Engine and Boat Manufacturers, one of the most popular figures in American yachting circles, has recently installed two new crankless oil burning engines in his 65 ft. yacht, *Silverheels*. This notable vescsel has completed a demonstration trip from Buffalo, through the Erie Canal, to New York City with numerous stops en route to exhibit the new streamlined engines. She has proceeded to Florida waters, where she is appearing prominently during the winter season. Additional stops were made at Baltimore, Washington and Norfolk on the way South and at various points along the coastal waterway such as Charleston, Savannah and Jacksonville. Winter anchorage was established at Miami with cruises along the Florida west coast, and she will soon return north.

The *Silverheels,* which was powered by Sterling gasoline engines previous to this conversion, is quite familiar to yachtsmen of many ports. Her new engines, however, deserve comment due to their unusual design, which is such a drastic departure from present standards.

This type of construction, in that the pistons operate horizontally with two in each cylinder, eliminates more than half of the normal reciprocating parts found in the conventional internal combustion engine. Among the most conspicuous of these are the crankshaft, camshaft, valves and cylinder heads. The number of bearings is reduced to a minimum and there is an absence of stress on working parts.

In the place of the crankshaft, without which no other engine can function, there is a straight shaft of greater strength which receives the power from the pistons through two inclined discs mounted one on each end. Only three bearings, under forced feed lubrication, are required to carry this shaft.

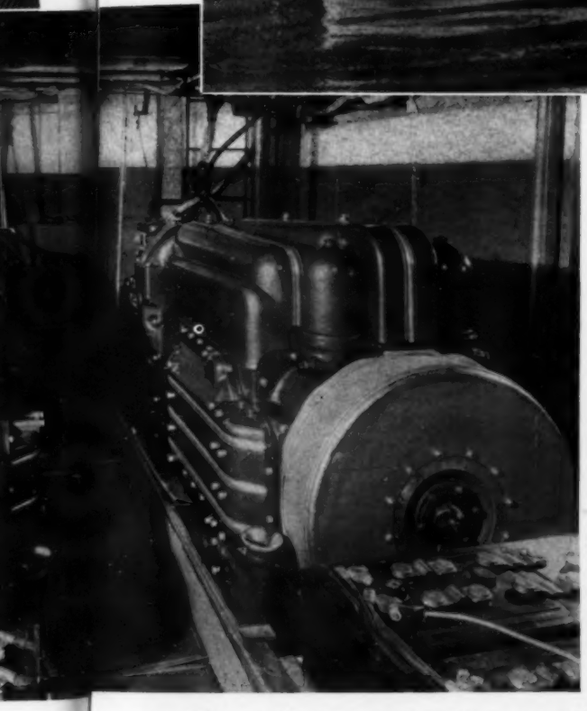
The elimination of cylinder heads is made possible through the absence of valves, valve springs, push rods and rocker arms, since all fuel and air for compression needs are admitted to the cylinders through ports that are opened and closed with the passage of the pistons along the cylinders. The same is true of the necessary air for scavenging.

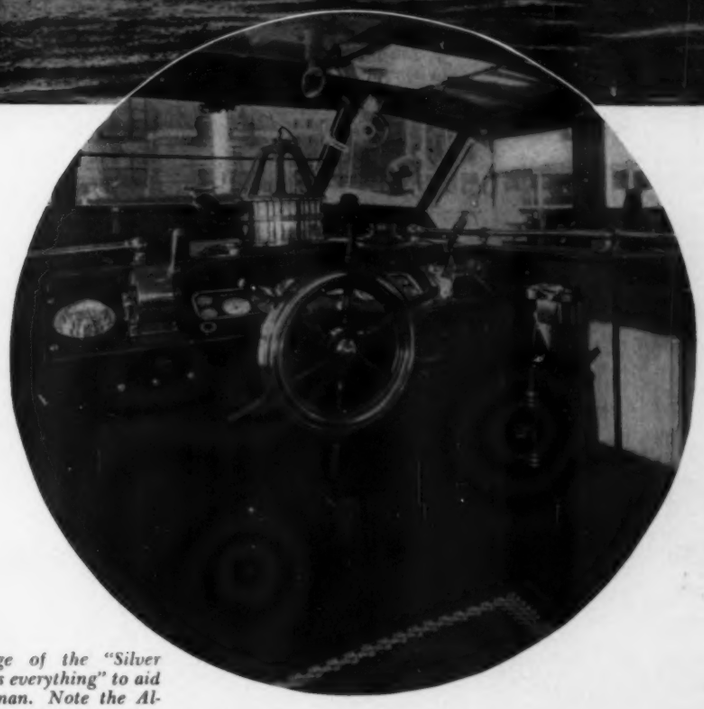
Both fuel and air are injected through pressure

Even the four Purolator lubricating oil filters are streamlined on the new Sterling, crankless, oil-burning engines. U.S.L. batteries appear in the foreground.

and combustion proceeds with a whirling action. The fuel is inducted through a method of atomization and is broken up into extremely fine particles to produce complete combustion for a maximum of power.

The air is introduced into the cylinders under a pressure of from 3 to 4 pounds per square





The bridge of the "Silver Heels" "has everything" to aid the helmsman. Note the Alnor exhaust temperature pyrometer and Reliance tachometer mounted directly by wheel.

inch. As the two opposing pistons approach each other this is compressed to a maximum of 500 to 550 pounds per square inch, producing a natural temperature of 1,000 degrees Fahrenheit.

Just before this temperature is attained the fuel is injected under a pressure of 2;500 pounds per square inch. The 1,000 degree temperature is sufficient to produce its own ignition without the aid of electrical devices. The same air processes are followed to produce a thorough scavenging of the cylinders at the end of the power stroke and prepare them for the next charge.

Cylinder heads, valves and cylinder head gaskets are omitted, thus eliminating the danger of cracks, blow-outs as well as the cold inner surface of the cylinder head. Likewise, the usual water jacketing for cooling is removed, except that directly around the cylinders.

Piston pins are eliminated through the use of ball and pad thrust bearings at each end of what normally would be the connecting rod, leaving the pistons free to glide horizontally in a straight line without side stresses. These bearings are of the Michell thrust principle almost identical in design with those used to take up the thrust on the propellers of giant liners and in huge turbines. Starting is through a standard electric starter, with a separate generator for charging batteries.

DIESELS vs. DROUGHT

By HERBERT W. ACASON

To make two blades of grass grow where one grew before is the height of human achievement. This the Diesel is doing in Eastern Colorado. Dry land is being turned into a garden through Diesel operated pump irrigation. Uncertainty in crop returns has been exchanged for guaranteed crops, an almost unbelievable situation in these days of drought and heat.

Eastern Colorado is dry land. The absence of trees or vegetation makes natural rainfall uncertain. But underground at depths of from 25 to 100 feet there is more than enough water to float all the navies of the world.

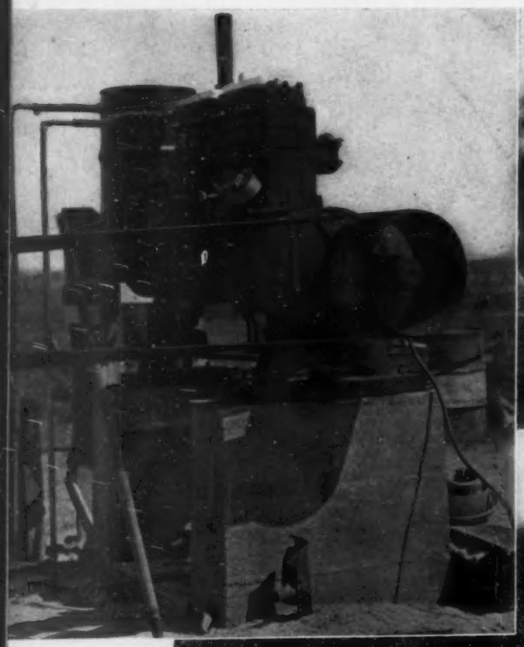
Ditch irrigation from mountain streams and reservoirs has in the past been the remedy, but this, too, is dependent upon rainfalls and snow in the hills. Farmers have to take ditch water as they can get it and at alternate times with their neighbors. It is also expensive and in many sections bond issues on dry land for irrigation projects have been a greater burden than the land can bear. Ditch rights for average farms may cost as much as $3,000.00, and even then be subject to the hazards of droughts and dry years for sufficient water to do any good.

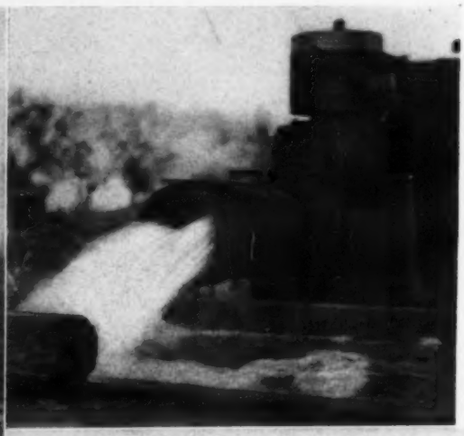
Pump irrigation is the farmer's own, personal, individual source of water. He can turn the water on when he wants it. It is his own water plant subject to no other control and comes from his own underground source of supply on his own land.

In sections close to towns and close to power lines this pumping is sometimes done by electric power, although usually at high cost. The percentage of dry land situated adjacent to power lines is small compared with those vast areas where such power is not available. The cost of extending power lines at $1,000.00 per mile is prohibitive and electricity needs to be available at a flat rate of not over ½c per kwh. to compare favorably with the cost of Diesel generated power.

When farmers first started to irrigate by pumping their underground water the attempt was made to do this work with tractors and tractor engines. It has been found that as the tractor engine is not built or designed for this type of service this is not an economical method. It is now very generally conceded that for twenty-four hour per day steady pumping under a constant load the tractor engine is being asked to undertake a type of load for which it was not intended. Gasoline engines were too expensive to operate and some very unsuccessful experiments were made with second hand truck engines.

This pump, belt-driven by a Cummins Diesel, is capable of supplying 2,000 gallons of water per minute to Colorado crops.





Water for this Colorado beet crop was scant and uncertain. The result is painfully obvious, yet this photograph and the one on the right were taken the same day not a half mile apart.

A Cummins Diesel pumping unit such as this can put approximately 2,000,000 gallons of water every 24 hours into irrigation trenches at a fuel cost of one-quarter of a cent per 1,000 gallons.

In the past few years the modern medium speed Diesel of from 40 to 85 hp., operating at from 700-900 rpm., has been the answer to this problem. Its comparative light weight and portability has lowered installation costs. Foundations have been simple and farmers have been able to understand the operation and care of these engines without difficulty or delay. The necessary service and instruction has been available.

Moderate engine speeds are very desirable, as in the irrigation season it is not uncommon for these engines to run 24 hours per day for 90 days in succession, the only shutdowns being for lubricating oil changes every 100 hours. During this period the load is constant and the Diesel engines that have been most satisfactory and free from trouble have been those that can develop the necessary horsepower at an easy operating speed. The Cummins Diesels illustrated herewith in pumping service operate at not more than 900 rpm. — in fact, 750-800 rpm. in practically all cases, and in two years' experience no customer has yet needed a major overhaul.

The procedure in providing a dry land farm with pump irrigation is to first have a well driller put down a test hole. The average cost of this is 50c per foot. Prior to this any water well driller will have a reasonably accurate knowledge as to whether water can be expected in the particular location or not. If the test hole is satisfactory then the well is put down and a turbine pump installed. The application of the required power then rests upon the Diesel salesman. With a knowledge of the depth from which the water has to be pumped and the capacity of the well in gallons per minute the horsepower can be figured accurately.

The preliminary testing of the completed well to find the draw down of the water under-pumping is usually done with a portable tractor, as this can be done in a few days before the permanent power is installed.

With the engine horsepower determined, the drive to the pump head can be either through a Johnson geared head or by flat or V belts. The geared head or V belt drives are to be preferred, as a flat belt has to be of some length in comparison and there is greater possibility of trouble with stretching and slippage. The belt centers and form of drive having been decided upon, the engine is installed and water poured on the land.

A Diesel irrigated beet field. Soil conditions, weather and growing periods were identical for these two crops. This one shows the result of plenty of water at the proper time.

BALDWIN CITY, KANSAS

By BENNETT B. SMITH

NEARLY a hundred years ago a group of pioneers was heading westward across the prairies of Kansas. When some fifty miles southwest of Westport, now Kansas City, they found a little stream of water and some trees — an oasis in the desert of treeless, rolling prairies. Here they built a log church and soon after that began a small college. The town became Baldwin City, Kansas, and the college Baker University.

It was the college that had the first light plant. It was a crude affair of the steam type and located in the basement of one of the buildings. It offered service to the college, some little to the faculty members, and to the town. This college-owned plant operated until 1906, when demands for a more efficient town plant had reached the state where steps were taken to supply one. A bond issue of $10,000 was voted to take over the college plant, to make some changes, and some new additions. It was not long, however, until this plant was obsolete. Natural gas, which was plentiful in the state, was being used for fuel, but this was gradually getting more expensive. Direct current was being used and the plant was not meeting the demands of its patrons. In 1917 another issue of $20,000 was made for the erection of a complete new plant.

Into the new project a Busch-Sulzer 165 hp. Diesel unit was installed at a cost of $13,500 which has far exceeded the expectations of the town in its performance. This unit ran twenty-four hours daily, seven days per week, with a shut-down of only two or three hours on Sunday for cleaning and making any needed repairs, over a period of seven years. At the time the extensive changes were made, lines were rebuilt and the current was changed to alternating. As the years passed along the load naturally increased. Many motors had been installed in the town and the city water system was depending upon the light plant for current to run the pumps. Seven years of almost constant running was quite a test for the unit and the city officials began to realize that too much depended upon the one unit and just what great inconvenience and danger would result if the plant should fail. The condition was remedied in 1924 by the addition of another Busch-Sulzer unit, the addition of a new switchboard, and some other minor repairs at a total cost of $20,000. No bond issue was necessary for these improvements, since the plant had paid excellently and money was on hand for the purpose.

The original unit and more recent one of 180 hp., both generating 230 kilowatts, are now operating at a minimum of expense and are giving the town excellent service. During all the time the old unit has been in operation it has been overhauled at a cost of $2,735, which included new pistons and liners. A cylinder head was replaced some few years ago. The second unit was overhauled in 1931 at a cost of $1,572. Street lights are run all night and are free from taxation, the plant taking care of the expense. All unsightly poles were removed from the business section and ornamental poles and underground wiring was installed, the cost for the whole work being paid for by the income from the plant. The plant has shown a gradual but constant increase in output. In 1936, 531,000 kw. were generated as compared with 505,500 for 1935. There were 55,000 gallons of fuel oil used last year at a cost of a little more than $2,000. Operation is carried on by the chief engineer and three assistants, one lineman, and one man to operate the water department. Total yearly salaries are $6,360, which includes the one employee of the water department.

The plant is valued at $90,000. For several years it was allowed to run down and only such repairs as were urgent were made on it and on the line. In 1930 a new city administration realized the importance of this city investment. Lines were almost completely rebuilt and the plant and engines were cleaned and painted. Open house was held for the whole community at which refreshments were served. Since that time everything has been kept in good condition with the units perfectly clean and painted.

Of the original bond issue there remains $1,000 yet to be paid. These are due in 1937 and would have been paid long ago had the owners preferred to let them go.

The Baldwin City resident rates are as follows:

First 25 kw., per kw.	7c
Next 25 kw., per kw.	6c
Next 25 kw., per kw.	4c
Over 75 kw., per kw.	2c

The minimum is $1.75. For those who do not wish to pay the above rates another is offered. This is a flat 8c rate with a minimum of 75c.

Business houses pay still a different rate. A minimum of 75c with a flat rate of 6½c per kw. regardless of the number used.

Baker University has yet another rate of 7c for the first 600 kw., 6c for the next 800 and 3c over 1,200. The minimum is $42.00 per month.

Commercial power is charged at 4c for the first 250 kw., 3c for the next 750 and 2c over 1,000. Minimum is $1.00 for the first horsepower on motors and 50c for each additional horsepower.

Meters are owned by the city and a deposit of $8.00 is required from each patron.

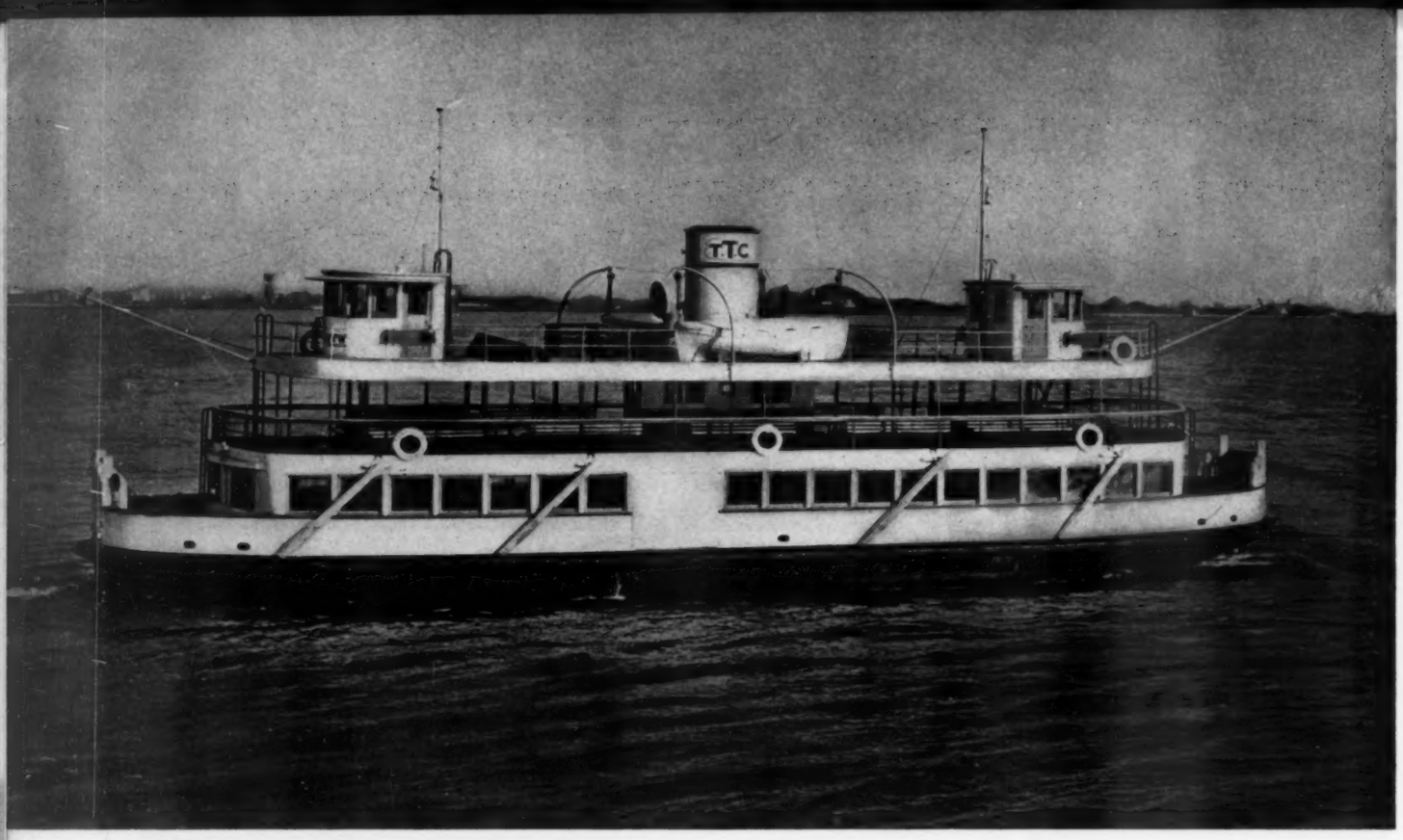
The building housing the plant is not a beautiful work of architecture but is plain and serviceable. It is 45 x 57 feet with flat roof and is located in the business section. The water tower, 128 feet high, is located at the rear of the plant. Some attempt at landscaping has been made with bushes and a lawn.

Baldwin City has a water system also worthy of note. This plant began in 1912 by damming a small creek and erecting a 7-foot wooden filter. This proved, in a short time, to be unsatisfactory as drainage was not sufficient and in dry weather, the water gave out. Tiling was then placed along the sandstone ledges to pick up the seep water and direct it into large cisterns. A natural sandstone filter was thus formed.

The spring, which was flowing 12,000 gallons per day, was not quite sufficient to meet the needs of the town and another search was made. Several more springs were found in the vicinity and were turned into the well. Two wells are now being used and are giving an abundant supply of water.

The municipal Diesel plant at Baldwin City and its personnel: Chief Engineer John Davison (seated), Maurice Fry and Paul Sutton.

The first Busch-Sulzer Diesel (in the background) operated 24 hours per day for seven years with only brief weekly shut-down periods on Sundays for cleaning and inspection.



DIESEL FERRY "WILLIAM INGLIS"

ON November 1, 1935, the ferry *William Inglis* pushed her blunt nose out into Toronto Bay, inaugurating her schedule of runs between the city of Toronto and Toronto Island.

Since that day the Fairbanks-Morse Diesel-powered boat has evoked enthusiastic comment from both owner and passengers. The Toronto Transportation Commission, owner, is particularly well pleased with the low cost of operation as compared with its other, steam-powered boats. Maneuvering also is much easier because of the flexibility of the Diesel engine. And the fire hazard, always dreaded on any vessel, has been minimized since heavy fuel oil is used instead of more highly combustible fuels.

Passengers, the thousands of people who enjoy the park facilities at Toronto Island and those who live there during the summer, are impressed by the boat's cleanliness, to which the use of Diesel power contributes in no small part. No annoying gasoline fumes permeate the air on board this modern ferry.

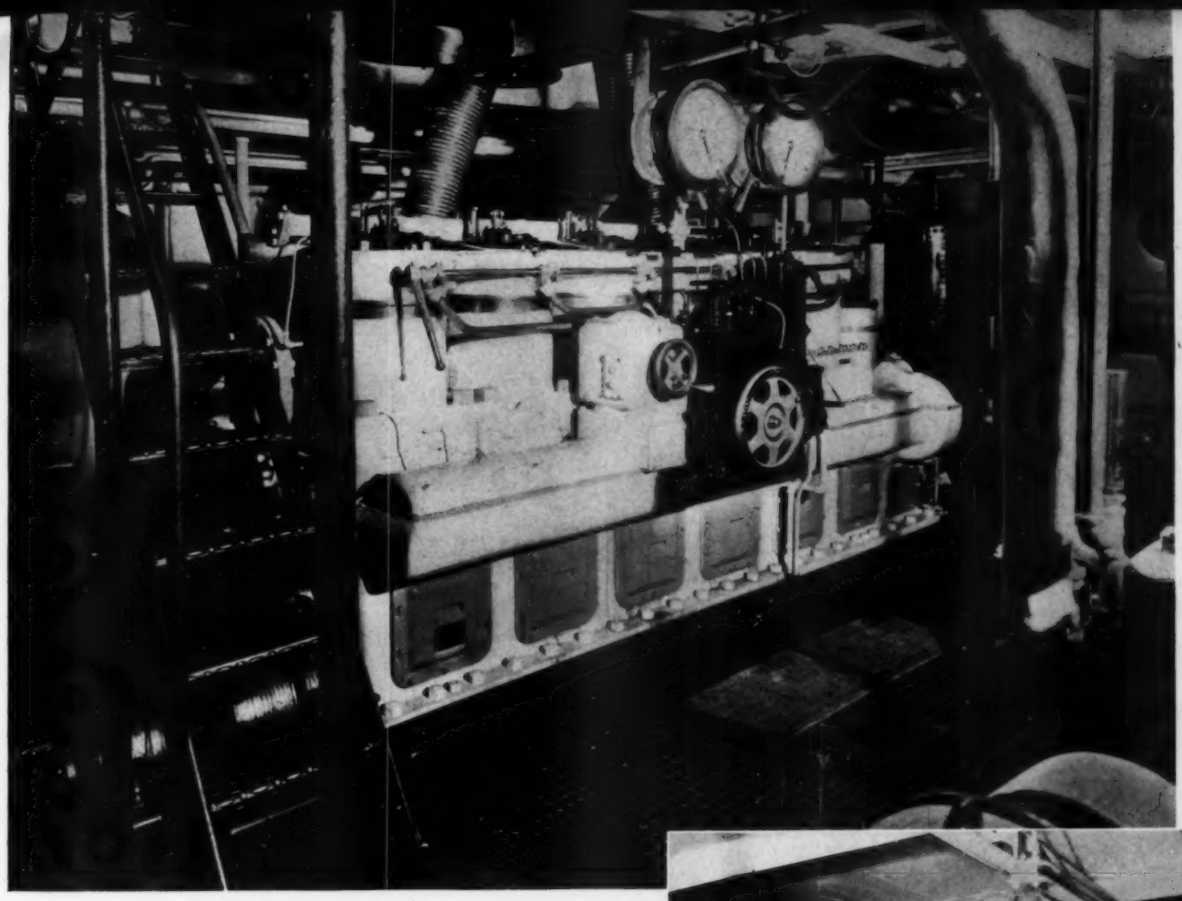
On behalf of the city, the Toronto Transportation Commission has for a number of years maintained a ferry service between Toronto Island and Toronto. In the spring of 1935 the commission decided to replace one of the oldest and smallest of its six steam-powered ferries and passenger boats with a Diesel-powered, double-end ferry.

In calling for bids, the city requested that bidders quote alternative prices for different makes of engines. The contract was awarded to John Inglis, Ltd., of Toronto, for the boat to be equipped with Fairbanks-Morse Diesel engine and auxiliary units.

The vessel, which is built to Lloyd's specifications, is 99 ft. long overall and 86 ft. 6 in. over stern posts; her breadth molded is 25 ft. and depth molded amidship 9 ft. 6 in. With a displacement of about 215 tons, she will carry 360 persons. Her speed is 10 mph.

Propulsion power is furnished by a direct reversible, 225 hp. 6-cylinder, 10-in. x 12½-in. 400-rpm. Diesel engine. The two 50-in., 3-blade propellers, one at either end of the boat, were designed by Fairbanks-Morse. Both of these propellers are operated at the same time; one pushes and the other pulls. They are driven direct from the engine through flexible couplings; no clutches are used.

One 10 hp. Diesel direct connected to a 3½-kw., 125-volt, D.C. generator furnishes light and power during the day. This engine also drives a 10 cu, ft. air compressor. Air for starting the Diesels is stored in four 20-in. x 60-in. tanks. A second 10-hp. Diesel is direct connected to a 6-kw. generator, which provides for night light and power needs. When the boat

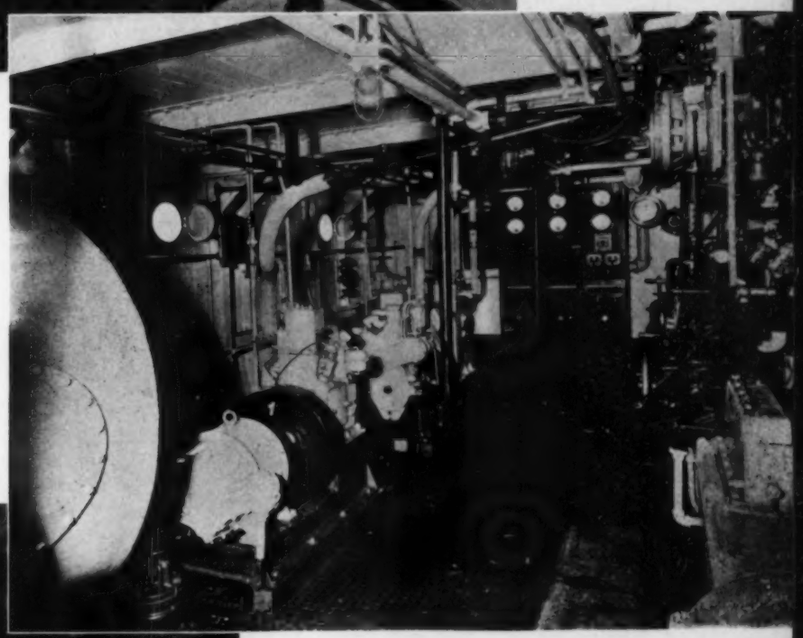


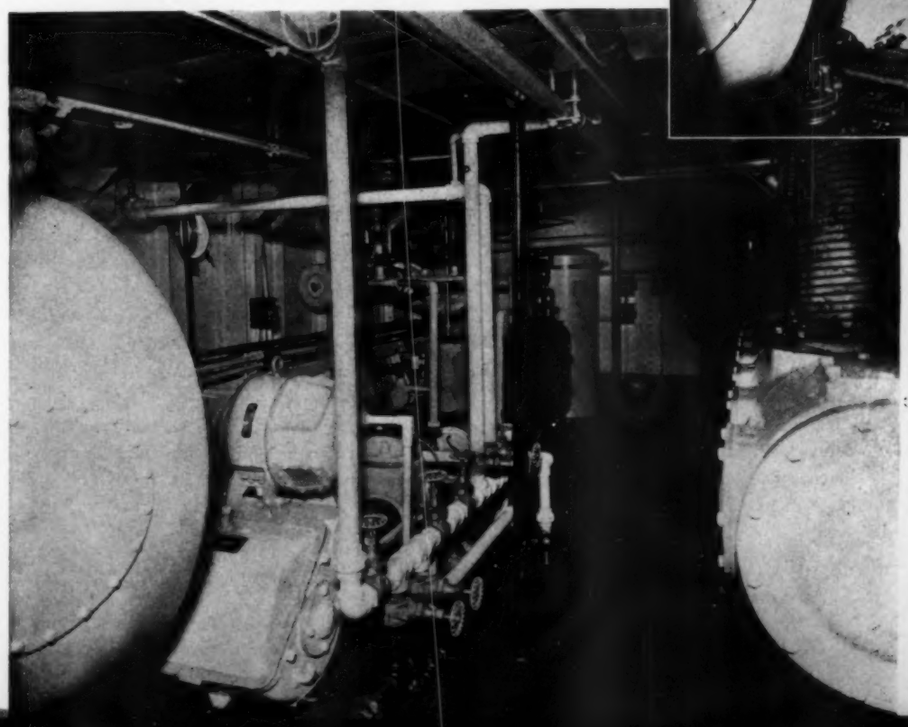
Port side of Fairbanks-Morse main propulsion Diesel with operating station for the engines.

is in port for long periods, power for lights and motors on board is obtained from the city power line through a 5-hp. A.C.-D.C. motor-generator unit.

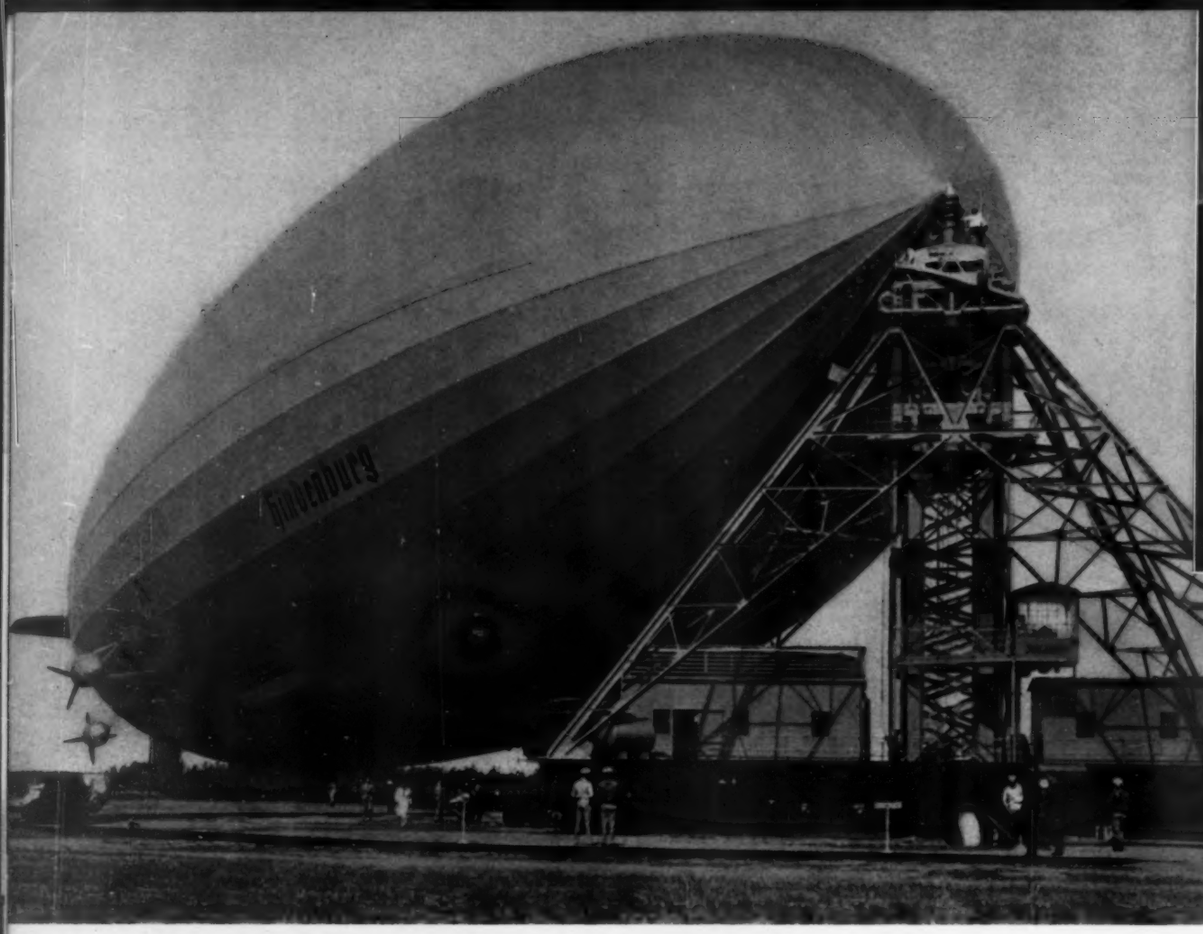
The engines are equipped with Maxim exhaust silencers.

The boat originally was named *The Shamrock*. After the death of Mr. William Inglis, president of the John Inglis Co., Ltd., builders, the name was changed to *William Inglis*.





The two general engine room views show how neatly and compactly all auxiliary equipment has been installed without sacrificing efficiency or accessibility. All pumping units on the "William Inglis" are Fairbanks-Morse, as well as the main engine.



Dr. Hugo Eckener, veteran of Zeppelin navigation.

The "Hindenburg" moored at Lakehurst, N. J. In the distance, the lower fin is seen secured to a weighted car which moves on a circular track around the mast.

RETURN OF THE "HINDENBURG"

The "LZ-129" Resumes Its Transatlantic Service

By PAUL H. WILKINSON

FEW people who in 1863 witnessed the first balloon ascent of young Count Ferdinand von Zeppelin at St. Paul, Minnesota, would have believed him to be the potential inventor of the rigid airship which bears his name. Such, however, proved to be the case. So impressed by its possibilities for lighter-than-air transportation was this adventurous young military observer who came to the United States during the Civil War, that on his return to Germany he began to work out his ideas and eventually left the Army to build his first airship.

It was in a floating hangar on Lake Constance near Friedrichshafen, close to the home of his family, that the *LZ-1* was finally completed. Although it had only two 15 hp. engines and was directionally unstable, nevertheless it succeeded in making a short flight at a speed of 20 mph., proving that the dirigible airship was practical.

The fantastic development of the Zeppelins is shown in the diagram on the next page. From the *LZ-1* with its cylindrical hull with conical ends, has been evolved the beautifully streamlined *LZ-129* which is familiar to so many millions of people today. One of the 50 hp. auxiliary Diesels on the *LZ-129,* used merely to supply the electricity on board, develops nearly twice the power available for propulsion on the *LZ-1.* Since the time of the first Zeppelin, the propulsive power has been increased from 30 hp. to 4,800 hp., and the volumetric capacity from 399,000 cu. ft. to 6,710,000 cu. ft.!

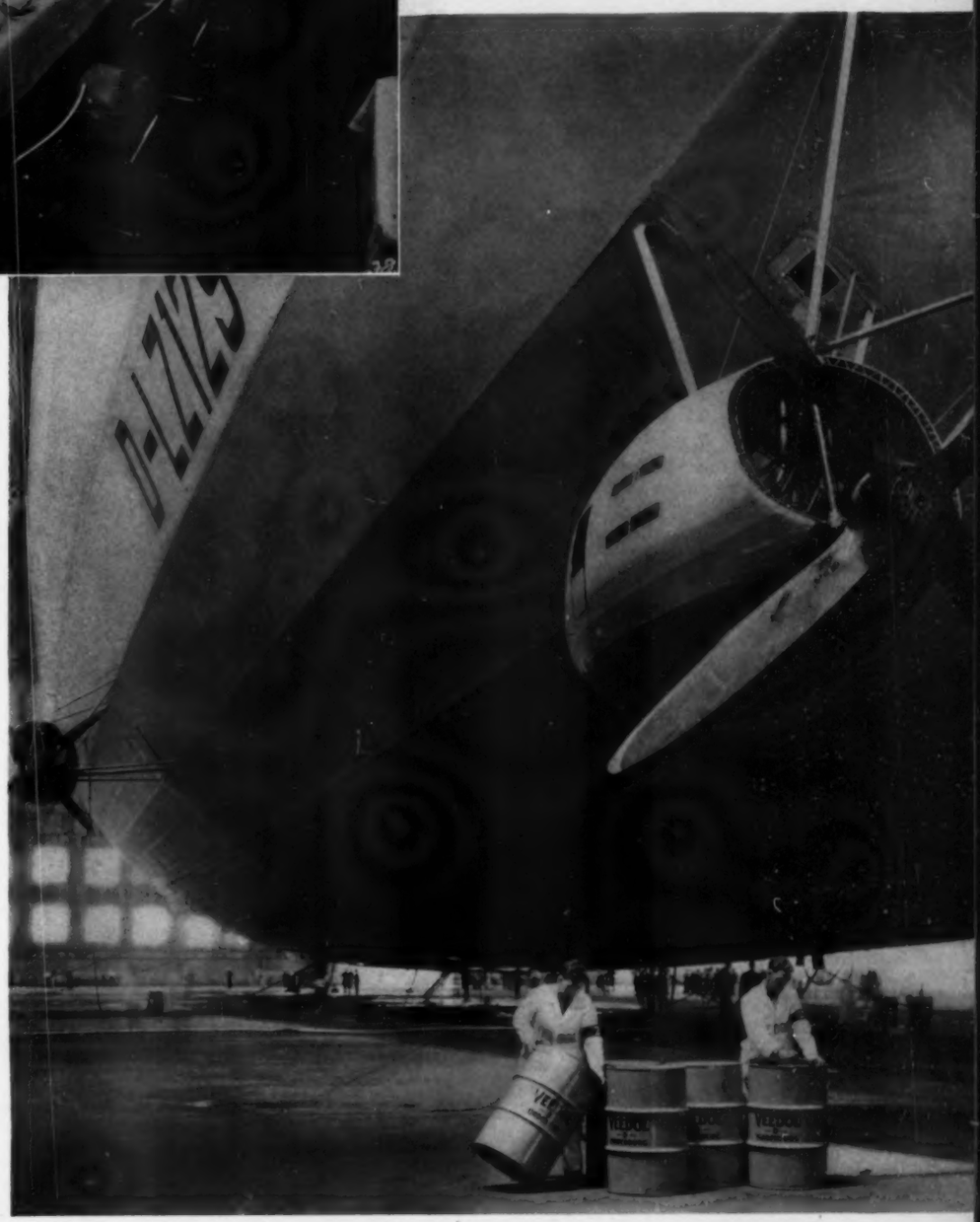
The serial number *LZ-129* used on the *Hindenburg* does not mean that it is the 129th Zeppelin to be built. Some of them existed only in the blueprint stage and only 118 of them actually were constructed. So far, 157 rigid airships have been built—138 in Germany, 16 in Great Britain and 3 in the United States. Of the German airships, 20 were of the Schutte-Lanz type which had a wooden framework. The *LZ-129* is the twelfth commercial Zeppelin of the series, the others being of the War-time variety.

While Count von Zeppelin and Dr. Eckener are so well known in connection with Zeppelin activities, little has been said about the man who is responsible for the design and construction of these huge ships. As technical director of the Luftschiffbau Zeppelin Corp. and head of the factory at Friedrichshafen, Dr. Ludwig Duerr has a vast amount of experience upon which to draw. Actually, he has worked on and directed the construction of all the Zeppelins, dating back to the *LZ-1* in 1900. It is greatly due to his technical ability and skill that the Zeppelin is so successful today.

Prior to the *LZ-129,* all the Zeppelins used gasoline engines for propulsion, as that was the only type available. With the advent of the

Left — A dining room in the skies! Thirty people can dine at one sitting amid these luxurious surroundings while flying over the ocean.

Below — The two port engine cars on the "Hindenburg."



LZ 1 (1900)
LZ 3 (1906)
LZ 5 (1909)
LZ 6 (1909)
LZ 8 (1911)
LZ 10 (1911) „Schwaben"
LZ 13 (1912) „Hansa"
LZ 14 (1912) „L 1"
LZ 18 (1913) „L 2"
LZ 21 (1913) „Z 6"
LZ 23 (1914) „Z 8"
LZ 25 (1914) „Z 9"
LZ 26 (1914) „Z 12"
LZ 36 (1915) „L 9"
LZ 40 (1915) „L 10"
LZ 59 (1915) „L 20"
LZ 62 (1916) „L 30"
LZ 91 (1917) „L 42"
LZ 94 (1917) „L 46"
LZ 95 (1917) „L 48"
LZ 100 (1917) „L 53"
LZ 104 (1917) „L 59"
LZ 113 (1918) „L 71"
LZ 120 (1919) „Bodensee"
LZ 127 (1928) „Graf Zeppelin"
LZ 129 (1936)

high-speed Diesel and its successful application in other fields of transportation, however, it was only logical that eventually it should be applied to the airship to solve the problem of economical transportation by air. Without the Diesel aircraft engine, it is safe to say that the profitable operation of lighter-than-air craft would be impossible.

Almost by the time these lines are written, the *Hindenburg* will be with us again. Compared with the ten round-trip flights across the North Atlantic last year, eighteen round trips are planned between Frankfurt-on-Main and Lakehurst, N. J., for the coming season. Such a full schedule will make it necessary for the airship to depart on the same day as it

Interior of the control car. In the bow is the wheel for the steersman, and to the left is the elevator control wheel. Above the latter is the water ballast diagram of the airship and the water valve controls.

Capt. Ernst A. Lehman (left), commander of the "Hindenburg," with Capt. Hans von Schiller, commander of the "Graf Zeppelin" which will soon be replaced by a Diesel-engined air ship, the LZ-130. (Courtesy German Railroads Information Office, New York.)

arrives, but at least this will give visitors at Lakehurst an excellent opportunity to see the mooring of the airship in the early hours of the morning and its departure in the evening—both extremely interesting and thrilling sights.

Conforming with shipping practice, the rates will be increased during the "season." From May 6 to July 14 on eastbound trips, and from August 13 to September 17 on westbound trips, the fare will be $450 one-way. "Out-of-season" sailings between May 14 and July 14, and from August 16 to November 2 on the east-bound trips, will be at the old rate of $400. The latter rate also applies to westbound trips between May 3 and July 11, and from Sep-

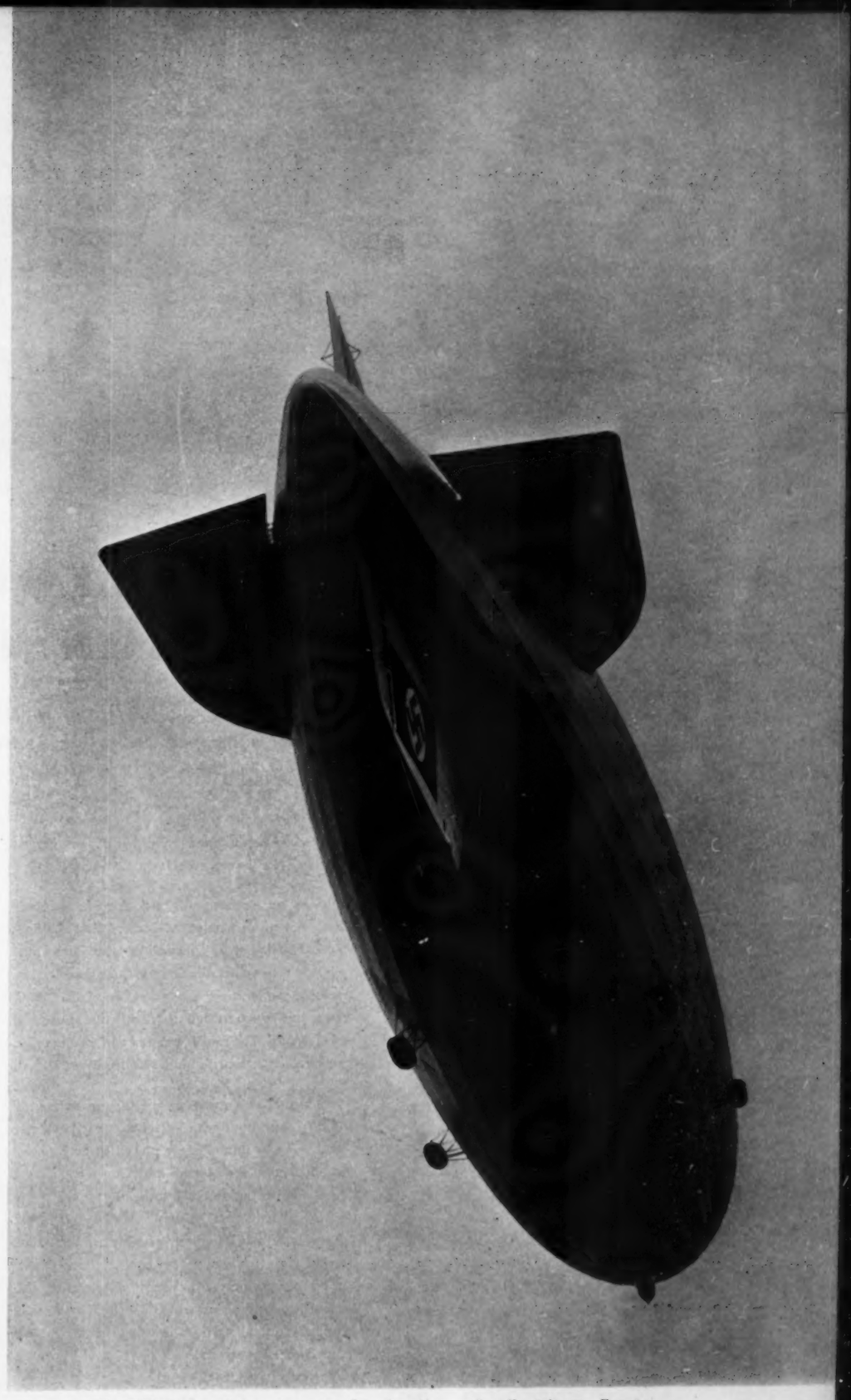
tember 28 to October 30. In addition to these journeys across the North Atlantic, fifteen round-trip flights are scheduled from Germany to South America later in the year.

So popular did the *Hindenburg* prove last year, that accomodations for twenty additional passengers were added on "B" deck, bringing the number of berths up to seventy. It has also been found possible to increase the baggage allowance from 44 lbs. to 65 lbs. per person. With only fifty berths, capacity loads were carried on its ten round-trip flights in 1936. According to official figures, 537 passengers were carried eastbound and 481 westbound, making a total of 1,081 passengers or an average of 53 persons per trip. Cargo up to 2,500 lbs. in weight was carried on some trips and on one occasion, a dismantled airplane was among the contents of the spacious freight compartments in the hull.

On the flights in 1936, including those to South America, approximately 135,000 miles were covered. Over the North Atlantic the average speed attained was 79 mph. eastbound and 67 mph. westbound. At times the speed of the airship reached 180 mph. when it was aided by favorable tail winds. The cost of each trip was approximately $28,000, which included Diesel fuel, lubricating oil, additional hydrogen, depreciation, salaries, insurance and terminal charges. The use of the mooring mast and landing facilities at Lakehurst was said to have cost Deutsche Zeppelin Reederei the sum of $60,000. In spite of the uneconomical operation of only one airship instead of two, the revenue derived from airmail at $0.40 an ounce and from the passengers at $400 a crossing enabled the operating company to pay expenses. It is probable that a larger volume of mail will enable the airmail rates to be reduced in the near future.

As is fairly well known by now, the *LZ-130* is nearing completion and will be ready for service this Fall. It will augment the passenger service to North and South America, and the famous *Graf Zeppelin* will then be retired and used as a training ship for airship crews. It is understood that the next ships, the *LZ-131* and *LZ-132*, will probably be slightly larger and will be equipped with airplane "hook-on" gear. Incidently, this has already been successfully accomplished with the *Hindenburg*. On these new airships, Mercedes-Benz Diesels will again be used, with a slightly increased power output.

The luxurious express passenger service provided by the *Hindenburg* cannot be equalled, of course, by the necessarily restricted quarters aboard the gasoline-engined flying boats and landplanes which the United States and Great Britain are rushing to completion for service across the North Atlantic this Summer. Here the greater Diesel cruising range is vital.



The "Hindenburg" departs on another four-thousand mile trip to Europe.

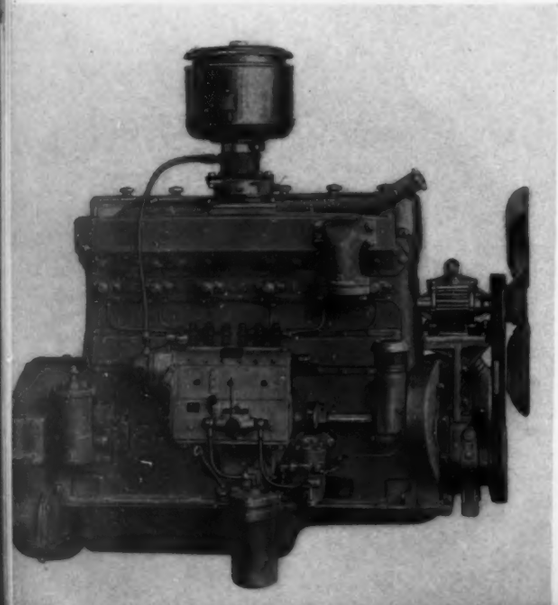
WM. McCULLOUGH TRANSPORTATION CO., Inc.

After Operating One Diesel Truck Six Months, This Company Places a Repeat Order for Seven More

RECENT years have witnessed the phenomenal rise of the motor trucking business from the individual small truck owner soliciting odd jobs to the present day great fleets of mammoth "expresses" for through freight service. Every night of the year these huge trucks, averaging from twelve to twenty tons gross weight, set out from practically every American city with merchandise of all description for delivery according to rigid transit schedules. As commercial trucking assumed its place with other American "big business" the owners and operators participating were faced with increasingly keener competition. Rates were lowered, time schedules stepped up and no excuses were tolerated for equipment failure.

In view of such conditions, the McCullough Transportation Company, Inc., of East Rutherford, N. J., began to consider the Diesel engine as a possible solution to their problem of reducing operating expense. In July, 1936, their investigation led to the actual purchase of a Ward LaFrance tractor and semi-trailer powered with six-cylinder, 100 hp. Buda Diesel.

This unit has a gross weight of approximately 40,000 pounds of which 24,000 capacity is pay load. It was immediately placed in active service between New Jersey and Connecticut and has been averaging 6,500 miles per month since with full load at all times. At the end of six months the truck had covered just under 40,000 miles with an average fuel consumption of ten miles per gallon. A comparison of costs with a gasoline powered truck of equal pay load capacity operating over the same route showed the Diesel saving to be $267.00 per month or in excess of $3,000.00 per year. At that rate, obviously, the Diesel engine will soon pay for itself out of reduced operating expense. There can be little doubt regarding the performance and reliability of the Diesel truck since Max Bendix, Inc., of North Bergen, N. J., who sold the original engine and truck, has received another order and this time for no less than seven of the same type and make. Repeat business on such a scale must of necessity mean a thoroughly satisfied customer.



The six-cylinder Buda-Lanova Diesel installed in the tractor-trailer unit above. With a 4-inch bore and a stroke of 5½ inches, this sturdy engine develops 100 hp. at 2,000 rpm.

This is but one of thousands of cases in which commercial truck men have purchased Diesel engines, placed them on the road in gruelling twenty-four-hour service, noted the results, economy and reliability and have then converted their gasoline units or replaced them with new Diesel trucks.

So far as stamina and lasting qualities are concerned we have but to turn to any of the Diesel trucks which have been running for several years to find almost unbelievable mileage records many of which are around the quarter million mark with the engine still functioning perfectly. All of these have paid for themselves many times over and are still operating satisfactorily at about one half to one third of what a corresponding gasoline truck would require.

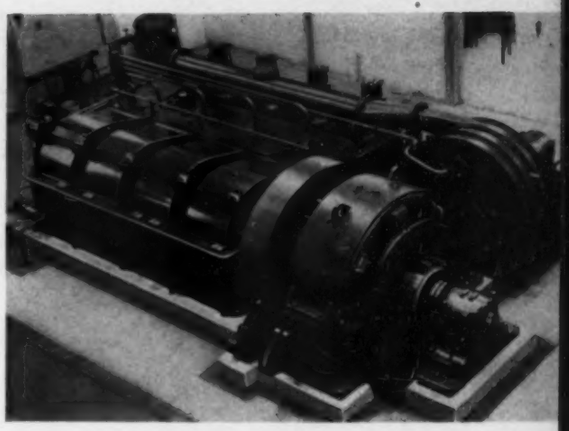
LONDON LETTER NO. 18

By G. R. HUTCHINSON,* M.I.Mar.E., M.D.E.U.A.

THE horizontal oil engine is not nearly so popular with American and Continental Diesel manufacturers as it is with British firms, many of whom have listed engines of this type from the earlier days of the industry to the present time. There was a time when certain misguided power users held the opinion that the horizontal engine was a thing of the past but some of the busiest engine manufacturers in this country are concerns whose current output is to a great extent represented by horizontal engines. Indeed, one could go further and state that just about the busiest industrial oil engine works in England at the present time is a firm which builds horizontal engines exclusively, namely Crossley-Premier Engines Ltd., of Sandiacre, nr. Nottingham. This concern, American readers may recall, was one of the earliest firms in the internal-combustion engine industry, some of the most noteworthy patents and developments in connection with supercharging standing to the credit of their chief engineer and designer, the late Mr. J. H. Hamilton. From builders of gas engines of various types this firm passed into the oil engine business; the foundations of their present great success being laid by Hamilton with his horizontal single line and *vis-a-vis* types which are built today with such modification as experience and improved manufacturing methods have suggested. The horizontal *vis-a-vis* type, with its ingenious big end construction, lends itself to the cheap manufacture of quite high-powered engines for it is only necessary to add a bank of cylinders to the back side of the crankcase with, of course, the special big end construction referred to, to double the power of the single line engine without adding to the overall length or complicating the crankshaft construction. The largest engine of this type yet built is a sixteen-cylinder pressure-charged unit of about 3,100 bhp., which power can be produced continuously without recourse to piston cooling.

Although this firm were early in the field with supercharging of a most interesting character, the system which is now employed on their engines is simple in the extreme, for it comprises a standard form of proprietary rotary blower, such as can be used for a variety of purposes, directly coupled to an electric motor. Such an arrangement is cheap, effective, and enables the power range of the standard engines to be appreciably extended. One of the most interesting of these engines which we have had the opportunity of seeing has recently been installed in the works of Crompton-Parkinson Ltd., Chelmsford, one of the leading English manufacturers of electric motors and generators. This engine, which is illustrated, is pressure-charged by the arrangement mentioned, the multi-stage blower and its motor being neatly incorporated at the end of the engine adjacent to the alternating current generator which the engine drives.

**Editor of "Gas and Oil Power" and Managing Director of the Whitehall Technical Press, Ltd.*

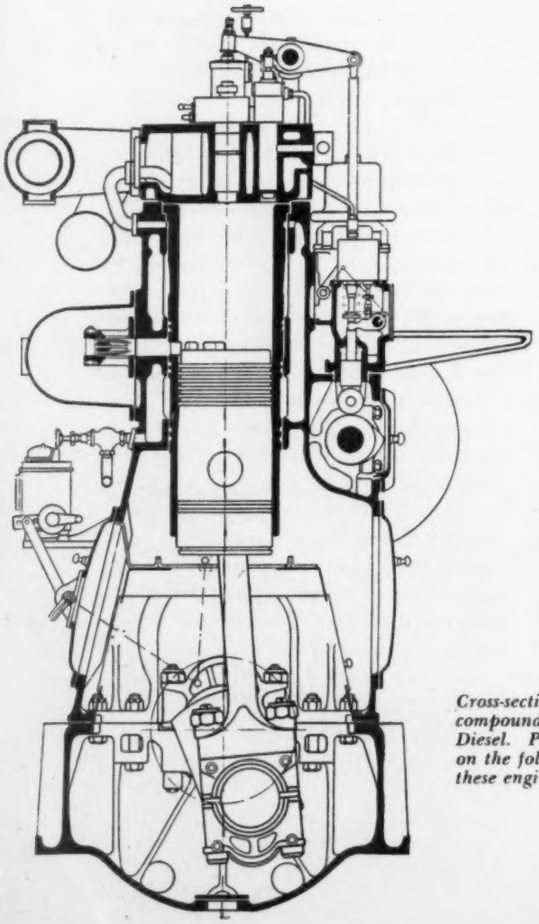


One of the Crossley-Premier horizontal supercharged oil engines which are finding great favor in England.

The Crompton-Parkinson generating station is noteworthy in being one of the most economical plants whose working costs are annually analysed by the Diesel Engine Users Association. Last year the all-in figure per unit generated was 0.361 pence, while for a period of 14 years the cost has been no more than 0.392 pence—a striking tribute to the consistently high efficiency of the Diesel engine. The other engines in this plant are of Sulzer manufacture, there being three four-stroke vertical units, each of 550 bhp. at 225 rpm. The new horizontal set is also of 550 bhp. at 273 rpm., this being the continuous rating with pressure charging. The generator is rated at 400 kw. 240 volts pressure, 25 kw. of this being required to drive the supercharging blower. The blower is capable of supplying 1,550 cu. ft. of air per minute at a pressure of 4.5 in. of mercury. The power required for driving the multi-stage supercharging blower is thus particularly small, while it may be mentioned that the fuel consumption curve of these pressure-charged engines is remarkably flat over a wide range of powers.

Three 4-cylinder, horizontally-opposed, 200 bhp. solid injection Diesels supplying electrical energy for a brewery at Trowbridge in Wiltshire.

Two of the three Tangye high-speed Diesel generating sets which supply power for the totalisator betting machine at the Newmarket track.



Cross-sectional view of the Sulzer compound-admission supercharged Diesel. Photograph at upper right on the following page shows one of these engines installed.

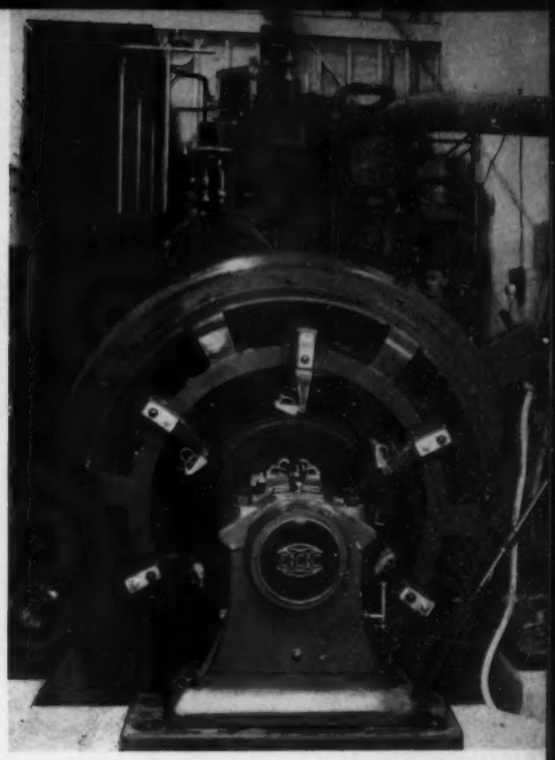
Horizontal engines also figure in another interesting installation which we had the opportunity of visiting a few weeks ago. This is in a brewery at Trowbridge, in Wiltshire, and comprises three four-cylinder horizontally-opposed 200 bhp. at 440 rpm. airless-injection Diesels which have been supplied by the Brush Electrical Engineering Co. Ltd. Each drives a Brush generator of 132 kw. at 1,000 rpm., 440 volts, through Texropes from the engine flywheels.

Unlike the Crossley-Premier engine discussed above, the Brush design is totally enclosed and has a fully forced system of lubrication to the various parts. The engine is of fairly recent design and is proving particularly popular, especially in the medium-power sizes. The manner in which the three engines are compactly arranged in line in the powerhouse will be noted from the illustration, as will the general simplicity of the station. Burgess air and exhaust gas silencers are fitted to all three engines and an outside cooling water tower operates in conjunction with centrifugal cooling water pumps driven off each engine. It is interesting to note that the Brush Company made engines, generators, and main switchboard, this versatility in the manufacturing sense being somewhat rare in this country.

The illustration of an installation of Tangye highspeed engines and generators which accompanies this letter is of particular interest because it shows part of the powerhouse recently completed in connection with the totalisator betting machine at the Newmarket Race Course in England. One of the largest totalisators of its kind in existence, the Newmarket installation is not the first to make use of Diesel-generated power but so far as we are aware it is the one with the largest independent Diesel power plant.

Three Diesels are employed and all are of the Tangye high-speed variety running at 1,200 rpm. There are two six-cylinder Ricardo Comet air-cell type engines of 60 bhp. each, each being directly coupled to a Crompton-Parkinson d.c. generator of 106 kw. for continuous duty; the peak load output is 116½ kw. These engines carry the normal load when racing is in prog-

One of the new type Diesel passenger buses being introduced to Ethiopian service between Massaua and Addis Ababa by the Italian Government.



ress and by reason of the fluctuating nature of the load, which may rapidly change from full load (or slightly more) to light load, the conditions are rather exacting. When a heavy day's racing is in progress the third engine, which is a four-cylinder unit of 40 bhp., may be called into service.

It says much for the reliability of the Tangye engines that they have performed this onerous service very satisfactorily since they were brought into commission some few months ago. When racing is not in progress the four-cylinder set is run to charge a 100-volt battery installation which provides current for lighting, etc., as well as for starting any of the engines through the ordinary electric starters and Bendix gear provided.

The Sulzer compound-admission four-stroke cycle engine is, so far as the writer is aware, unknown in America, although a number of these units have been installed in British Diesel powerhouses and in motorships as auxiliary engines. Briefly, the idea is to attach a small reciprocating type supercharging pump to the front of the crankshaft of a four-stroke cycle engine, this pump supplying scavenging and "topping up" supercharge through a row of ports at the bottom of the cylinder liner. The normal air charge is taken in through the usual inlet valve in the cylinder cover, this secondary charge being introduced at the bottom of each downward stroke of the piston at a pressure slightly in excess of atmospheric. The arrangement ensures good scavenging of the combustion space and allows of a higher mean effective pressure being carried without distress to the engine and with very little additional mechanical complication.

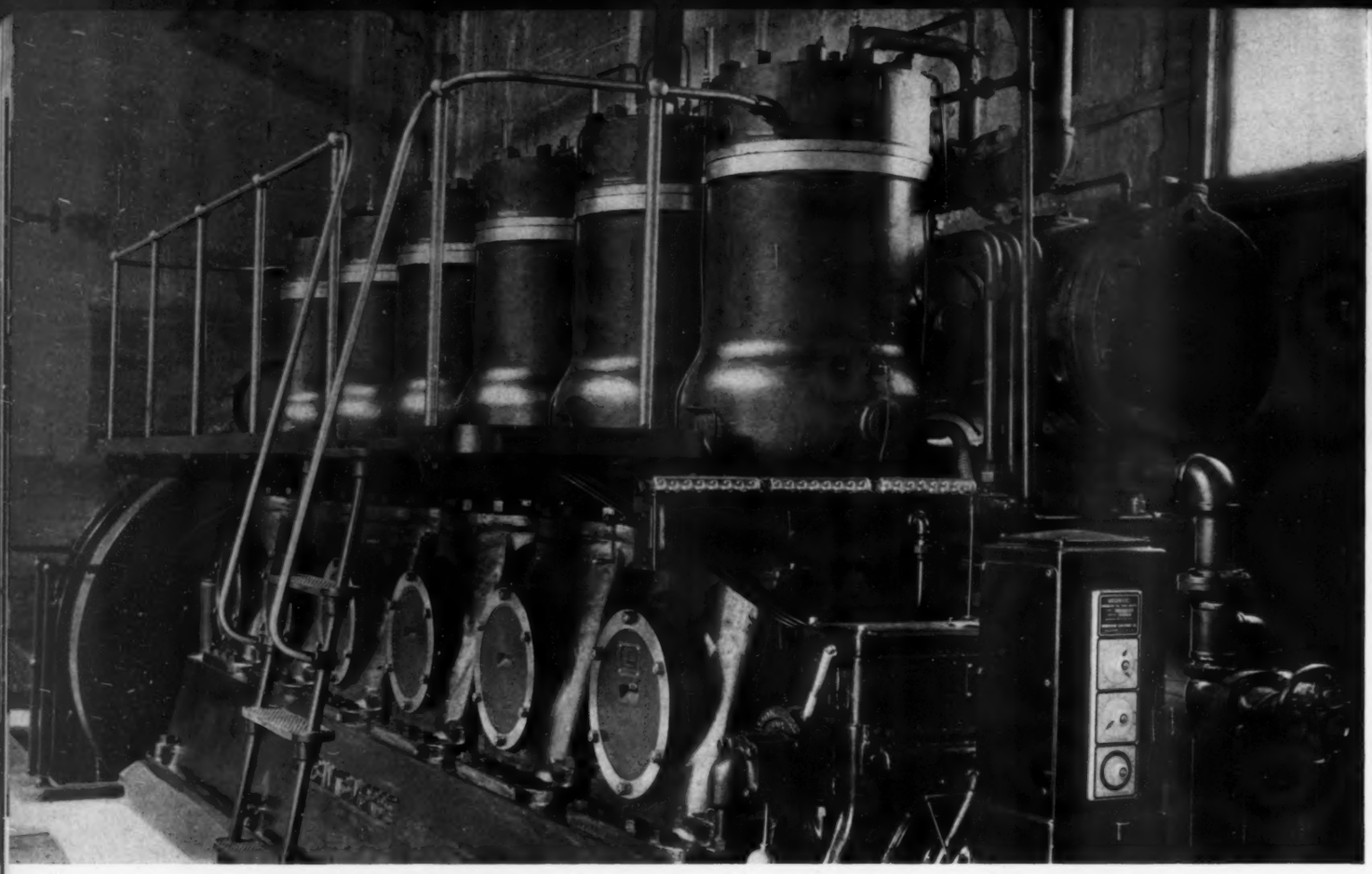
The first stationary engine of this type to be installed in this country was recently inspected by us in the motor works of Dennis Bros., at Guildford, a few miles out of London. This is a particularly busy commercial vehicle factory which already had an independent Diesel plant comprising Sulzer and Mirrlees-Ricardo high-speed Diesel-generating sets. Recently, however, it was found necessary to increase the plant, which now has a total output of about 1,900 kw. Space being limited, it was decided to utilise an old battery room for the installation of the new set, which, as our illustration shows, is a remarkably close fit for the engine house. The engine is a 500 bhp. at 375 rpm. six-cylinder airless-injection unit which drives a 340 kw. 440-volt generator and the set is quiet and steady in operation.

A section through the cylinder of the Sulzer engine installed in the Dennis works is herewith, from which the principal features of the novel design may be gathered. It may be mentioned that at normal full load the pressure produced by the supercharging pump is about 4 lb. per sq. in. (gauge), while an interesting feature of the design, according to the builders' claim, is that the power absorbed by the supercharging compressor is only about 40 per cent of that required in supercharging systems where the whole of the air charge has to be compressed and fed through the inlet valve or valves in the cylinder head.

It is with profound sorrow that we are forced to announce the untimely death of Mr. F. George Lind, who for the past year and a half has contributed such interesting and timely London Letters. That Mr. Lind's articles were one of the most popular features of DIESEL PROGRESS, there can be no doubt, since hardly a week went by without some complimentary expression from our readers regarding his reports of Diesel activities and designs not only in Great Britain but on the Continent as well. Although relatively young in years, Lind had a remarkable "nose for news" which, coupled with a thorough understanding of engine design, manufacture and operation plus his pleasing literary style, insured the readers of DIESEL PROGRESS up-to-the-minute advice and information regarding foreign Diesel developments. We are convinced that thousands of DIESEL PROGRESS readers, although not acquainted with Mr. Lind personally, will share the loss so keenly felt by the staff of this magazine.

The London Letter, as a monthly feature of DIESEL PROGRESS, will continue without interruption. Beginning with this issue it will be ably handled by Mr. G. R. Hutchinson, Mr. Lind's associate and superior. Mr. Hutchinson is the Managing Director of the Whitehall Technical Press, Ltd., and editor of *Gas and Oil Power* which is pubished by the organization together with *The Marine Engineer*.

Editor, DIESEL PROGRESS.



450 hp. 6 cylinder Fairbanks-Morse Diesel, one of the units so faithfully and economically serving Terrell's municipal power requirements. The Woodward governor appears prominently in the foreground.

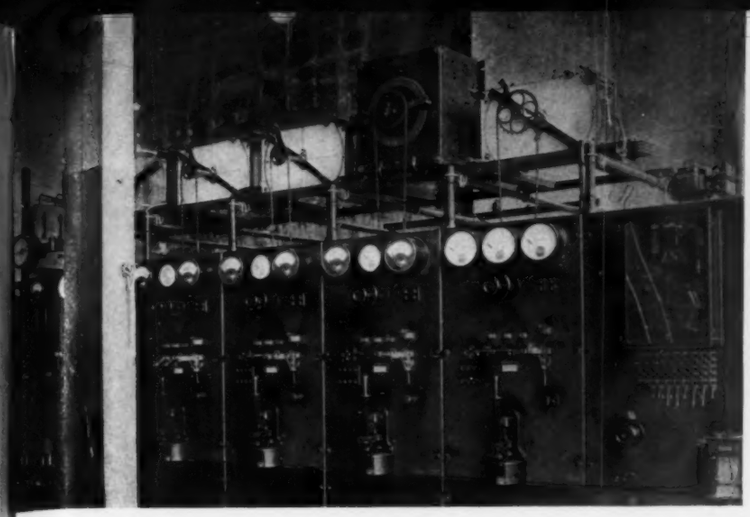
TERRELL, TEXAS

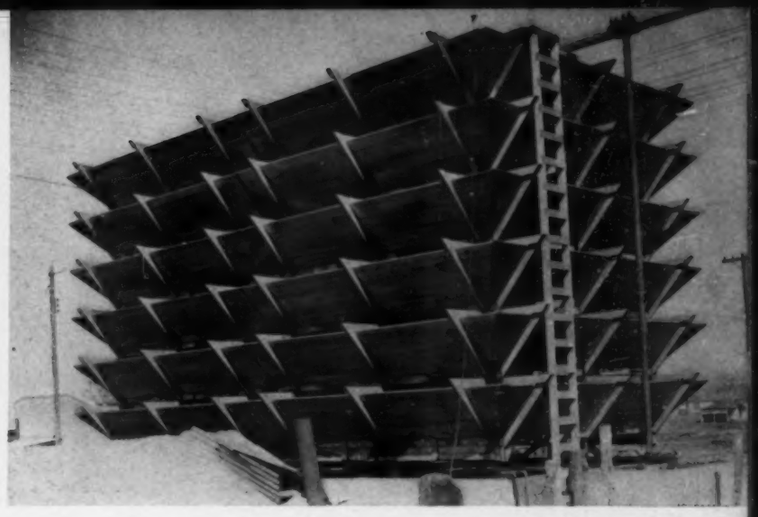
By ORVILLE ADAMS

LOCATED twenty-eight miles east of Dallas, with a population of 9,000 people, Terrell, Texas, is a thriving center of a rich blackland agricultural section, noted for its schools and progressive enterprise unexcelled anywhere. About fifteen years ago, the town abandoned its old steam plant and changed its city government. It adopted the Diesel and city manager form of government. Shortly thereafter Mr. L. A. Markam was made City Manager. Starting with two 200 hp. Diesel engines, he has built the plant up to six engines totaling 1,410 hp., having recently installed a new 450 hp. Diesel with the idea in mind of taking the original two 200 hp. semi-Diesels that have seen fifteen years of continuous service out of service, leaving an up-to-date plant of 1,000 hp., consisting of four units. All of the Diesels and alternators installed were manufactured by Fairbanks-Morse. For fifteen years the Diesel plant has been paying its way, buying engines out of revenue and contributing each year a large sum to the city's general fund that resulted in a great saving to the taxpayer. The water and light department, according to Mr. Markam, contributes $25,000 a year to the city's Principal and Interest Sinking Fund of $33,000 required to meet the annual payment on the city's bonded indebtedness, there being no debt against the light plant, which, instead, has a surplus of approximately $40,000.

The Diesel light plant pays cash for new equipment, maintains a surplus fund to meet extensions and improvements, sets aside a special fund for maintenance and, in addition, turns over to the city a profit of more than $10,000 a year out of its net revenue of approximately $21,000 annually which it is able to realize from a gross of $55,000 from the sale of current, this being the average for several years. In other words, the light plant retains about one-half of its net earnings in a special fund or surplus, which occasionally is almost as large as the city's total tax income. And the light plant surplus fund actualy does a banking business with the city, loaning various other city funds money during the year to avoid overdraft of those funds and payment of interest. "We couldn't run the town," says City Manager Markam, "without the light plant. Usually the light plant finances the town when funds run short, for many times the light plant has more money in the surplus account than the city collects by taxation. Of course, we reimburse the light plant fund when the money comes."

And when the depression struck with full force the impact on the financial affairs of the town was considerably softened during those trying years, by the constant monthly inflow of money from the city's utilities, light plant, water works and sewers. Just what the continuity of expert city management combined with the operation of municipal utilities really means in terms of results has been demonstrated in no uncertain manner to the citizens during the past several years when a great many communities without these things were subsisting on Governmental charity. "Always free from debt, our Diesel plant, which we have tried to operate efficiently, has been a great factor in the growth and sta-





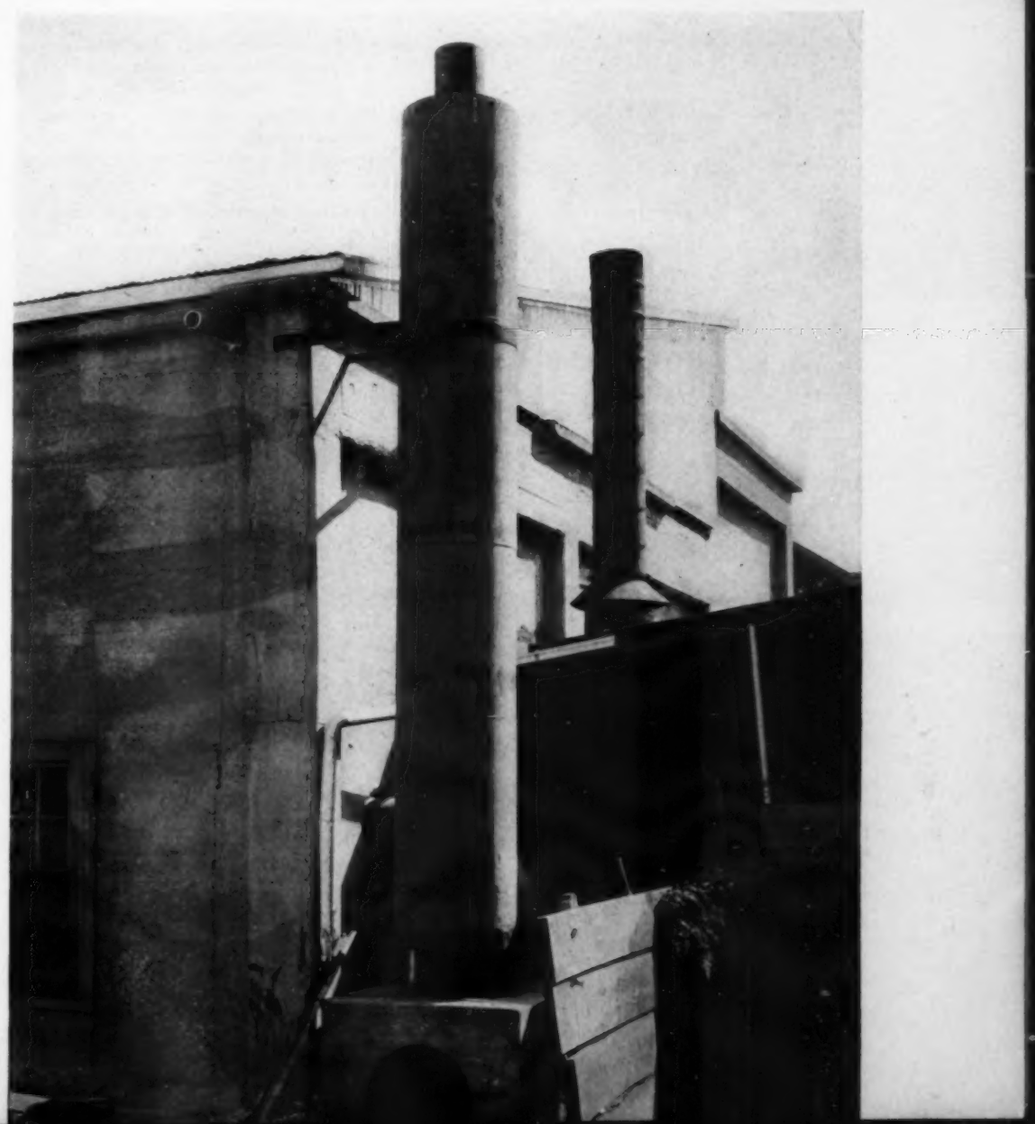
bility of our community," says Mr. Markam. "Our bonded indebtedness for schools, streets, sewers and the like would require a levy of $1.20 per hundred to meet the payments on this item alone, if it were not for the $25,000 a year which we are able to take from the earnings of the light and water plant. As it is, this levy is only $.23 per hundred dollars of valuation." And there are many other benefits which Mr. Markam pointed out.

The city will eventually be able to eliminate all tax levies with the exception of schools and sinking fund requirements. There will be no taxes required to operate the city government, maintain its streets, police and fire departments and operate its utilities. The money from this utilities operation will be used for this purpose. This is now Mr. Markam's objective.

A particular advantage of the Diesel engine as a power unit, Mr. Markam was careful to point out, is that any size of unit can be installed to meet the need for power, without planning too far ahead. The plant now has six engines, but will begin to take out the older and smaller engines and replace with larger units as the demand develops. The engines to be taken out, although they have been in operation for fifteen years, are in good condition and have been sold for 25 per cent of their original cost, the appraised value being based on a life of twenty years. The engines are not being replaced, he says, on account of being worn out or necessarily obsolete, but to make room for larger units.

With the four remaining units, the plant will be able to take the peak load with three different combinations of engines, having a plant capacity of more than double the peak load. While this results in a low running plant capacity factor, it does make possible the operation on all loads an engine loading that is most efficient. The plant has had 100 per cent stand-by capacity for more than 10 years, and been able to operate with three or more engine combinations in parallel operation. The result is there has never been any possibility of the power being off but for a few moments. The fifteen year record for outages remains unequaled, claims the superintendent and chief engineer, Mr. E. P. Burch, who has been largely responsible for the selection of engines and equipment, and the flexibility of layout that has been developed as the plant has grown with the years. Many aids and adjuncts to efficiency of operation have been added by Mr. Burch. The new 450 hp. Diesel engine installed in February, 1937, is fully equipped with all the approved auxiliaries. The first four engines were operated without pyrometers, silencers, air filters and centrifuge equipment. The latest engine has all of these, including water cooled exhaust manifold. The use of all the necessary auxiliary equipment will result in the improvement of the general overhaul efficiency of the engine fully 25 per cent, Mr. Burch thinks. The fuel and lubricating oil is to be treated by centrifuging through a Goulds Hydroil, which will result in much less maintenance, engine cleaning and wear on the engines. A large cooling tower with ample capacity to take care of the entire plant, regardless of the number of engines operating, has been built. The fuel tanks with a capacity of 65,000 also have an advantage inasmuch as four or five months' fuel supply, or about eight tank cars,

The engine shown on the preceding page is efficiently served by this Maxim exhaust silencer.

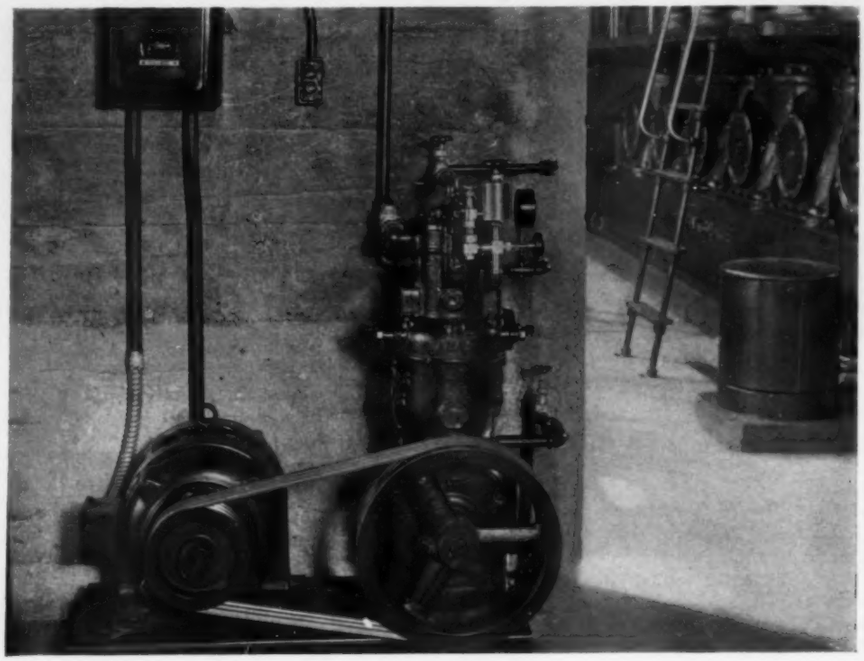


can be received at one time and bought when the price is attractive. There is also a large underground fuel tank for use in winter, if the fuel happens to be a high pour test fuel, which must be protected from winter temperature.

All the engines except the new unit employ the pit exhaust with exhaust stack going through the roof. This arrangement, which Mr. Burch suggested, consists of a horizontal exhaust manifold piped to a concrete pit outside the building, the pit being above ground. The Maxim silencer connects with the exhaust pit, as shown in the illustration, and not with the exhaust manifold or pipe. This reduces back pressure and minimizes vibration of the exhaust impulse. The operation is very quiet and practically inaudible a short distance from the power plant. The foundation is likewise properly isolated from the building floor by the use of insulation material.

The plant has been generating from 1,555,000 to 1,600,000 kilowatt hours per year. After deducting line losses, there remains for sale, according to the bills for current, approximately 1,300,000 kilowatt hours, which is sold at an average of about 4½ cents gross, the total income from the sale of current for the fiscal year ending March 1, 1937, being $56,771.97.

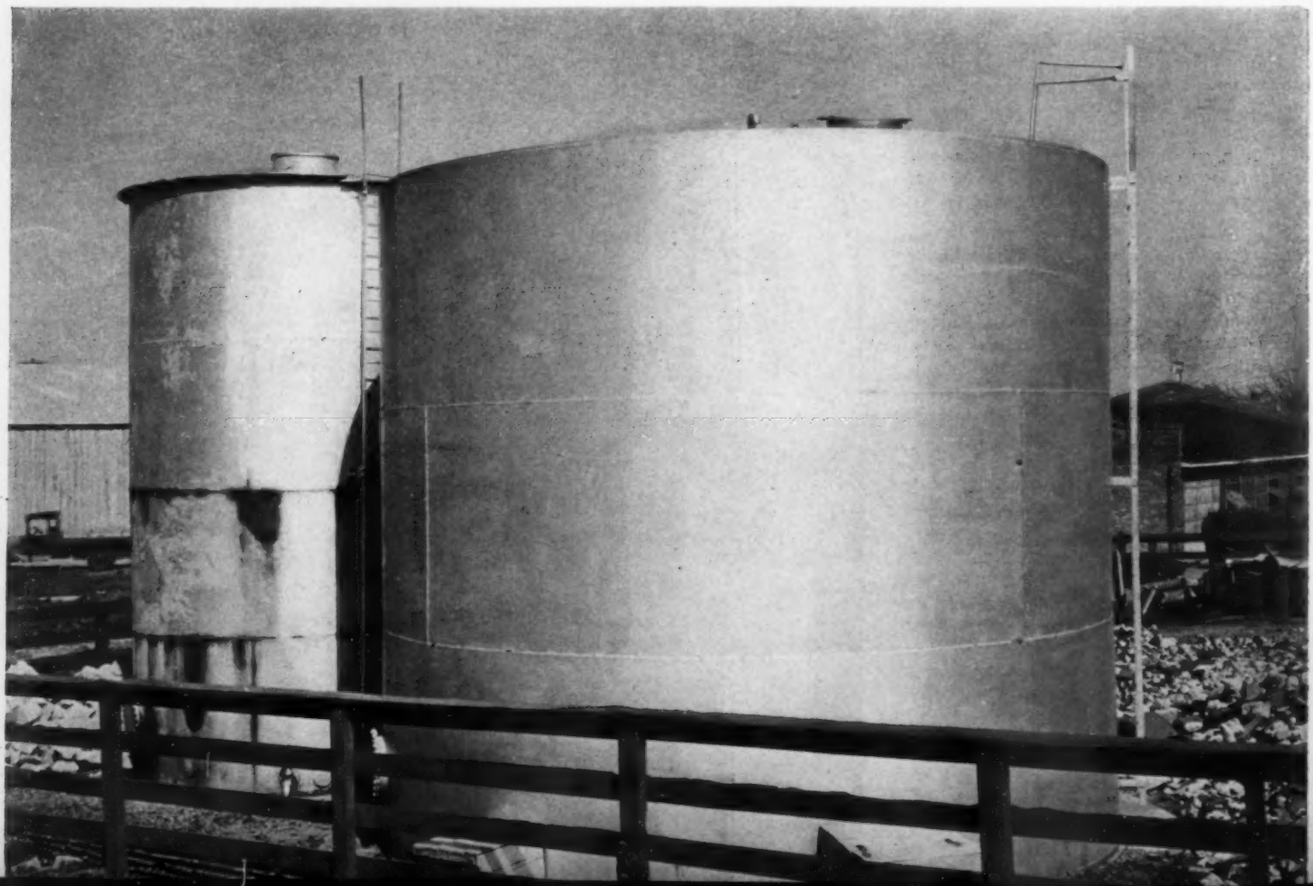
A completely modernized switchboard with every necessary instrument has recently been installed, including recording totalizing meter, recording voltage meter, telechrome clock controlled voltage regulator and Brown pyrometer. The new board is converted to the dead-front type, and has been completely rewired. The switchboard is General Electric throughout.



For Diesel starting air, Terrell depends on this Gardner-Denver motor driven compressor.

During the interview with Mr. Markam, he discussed many advantages of municipal operation of utilities and Diesel power plants, stressing the importance of efficient operation of the entire system, proper appreciation of the requirements for successful Diesel installations, as well as good management. Profits, he says, from the operation of its own utilities, light, water and sewers, will properly operate practically any small town from the size of Terrell to cities of much greater population, if proper layout is made for Diesel engine generation of the power required, which today is the city's largest item of expense.

Two fuel tanks of 65,000 gallons combined capacity afford ample storage facilities for attractively priced oil.



Cummins Diesels enter water taxi service in San Pedro Harbor, Calif. There is probably no more gruelling work for engines, hulls and personnel in the whole marine field than this. Not because of weather or sea conditions but due to fixed schedule, continuous operation at PEAK LOAD.

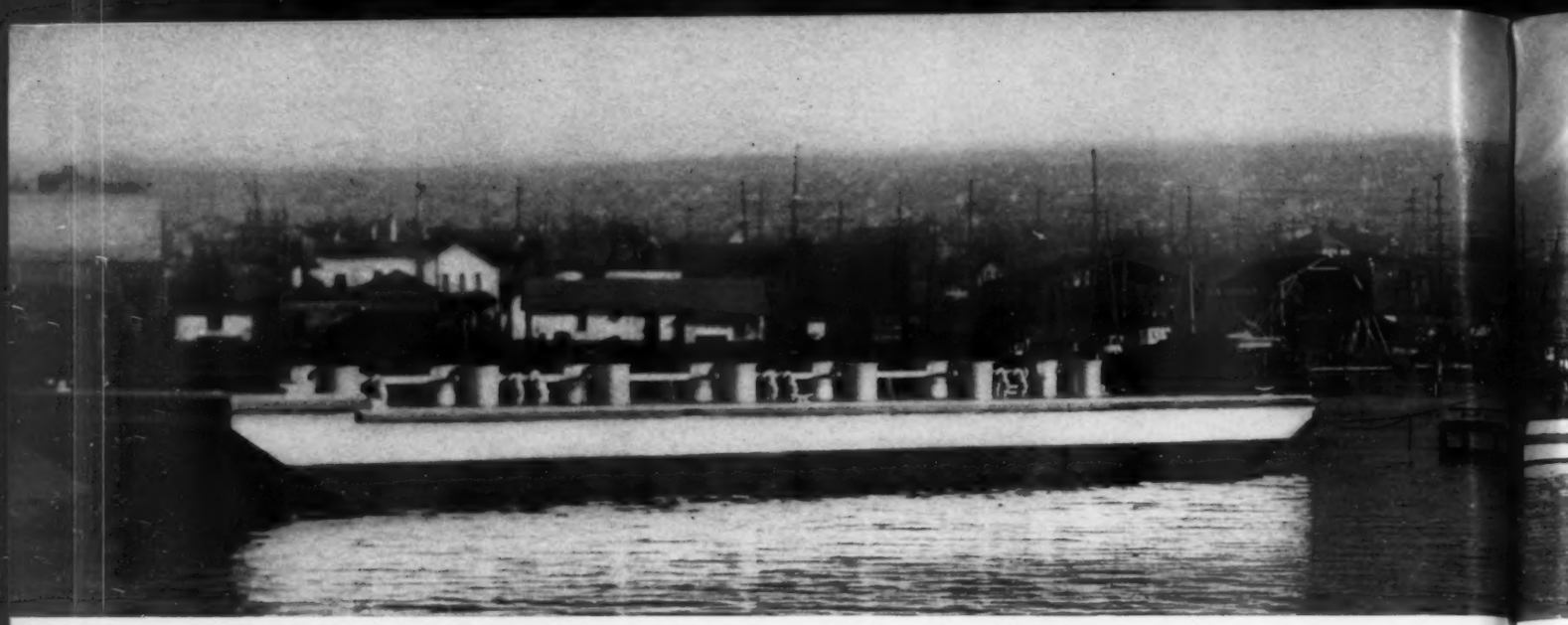
DIESEL WATER TAXIS

THE H-10 Water Taxi Co., Ltd., was organized in 1920 to operate a fleet of launches between San Pedro and the ships at anchor in that famous and busy harbor. Messrs. Vail and Bartell, executives of the company, explained that the H stands for home port men and 10 indicates the number financially interested.. Starting with the original ten boats, the fleet now numbers 17 and has enjoyed a remarkably successful career collecting as much as $195,000.00 in one year from 25c fares, in addition to handling $35,000.00 special charter business. These figures give some conception of the necessity for most dependable hulls and motors which must be instantly ready for continuous service, day or night.

Until recently gasoline powered, these vessels were using $6,000.00 worth of fuel per month and monthly sparkplug charges alone ran as high as $300.00. Obviously, a very vital need existed for a reduction in operating costs if such were possible without sacrificing thorough dependability. The solution was found in the installation last November of a 125 hp. Cummins Diesel. This unit replaced a 275 hp. gasoline engine which drove its boat at 14 knots. By equipping the Diesel with a 2 : 1 reduction gear to swing a larger propeller the speed is now 13½ knots and the advantages . . . but let Mr. Vail use his own words. "We were burning 17 gallons of gasoline per hour for 20 hours a day in No. 9," he said. "For gas alone it was costing $35.00 a day just to run the engine. With the Cummins Diesel we use 4 gallons of fuel per hour at 3½c per gallon or a total fuel cost per day of $2.80. By golly, we'll save enough in fuel bills alone to pay for the Diesel in 100 days." So enthusiastic are the other members of the H-10 Company that they have ordered 16 more Cummins Diesels for the balance of the fleet and, after all, repeat orders are the surest proof of Diesel satisfaction.

An interesting feature in the conversion of No. 7 and No. 19 is that the Diesel engines weigh 800 pounds less than the gasoline units. Actually, of course, the weight per horsepower is about the same but, due to the higher torque of the Diesel, it is possible to get the same speed with less horsepower rating.

The H-10 Company are the first water taxi operators to go 100 per cent Diesel and the completion of their present program will involve about $50,000.00 in engines alone.



The new shallow draft 400 hp. Winton Diesel tug, "Mary Gail," and her companion unit, a light steel tankerbarge.

FIRST MARINE DIESEL EQUIPMENT FOR UPPER COLUMBIA RIVER

By CHARLES F. A. MANN

OF widespread interest is the design and construction of a series of unique Diesel driven river boats and barges for use on the upper Columbia River, above Bonneville Dam, now nearing completion by the United States Army Engineers at the west entrance to the spectacular Columbia River Gorge, forty-five miles east of Vancouver, Wash.

Because the mighty Columbia, America's second river, is a natural funnel for highway, rail and air transport between the rich Columbia Basin and intermountain area and the Pacific, the application of Diesel driven river craft to operate in the pool formed back of Bonneville Dam to the mouth of the Snake River at Pasco, Washington, is one of the major new engineering problems of both engine and ship builders. With a preponderance of traffic westward, consisting of wool, wheat, lumber, canned and fresh foods and a lighter eastward movement (upstream) of petroleum products and the array of articles in ordinary wholesale trade, vessels for this service cannot simply be just "another freight boat," nor can they be just "Diesel vessels."

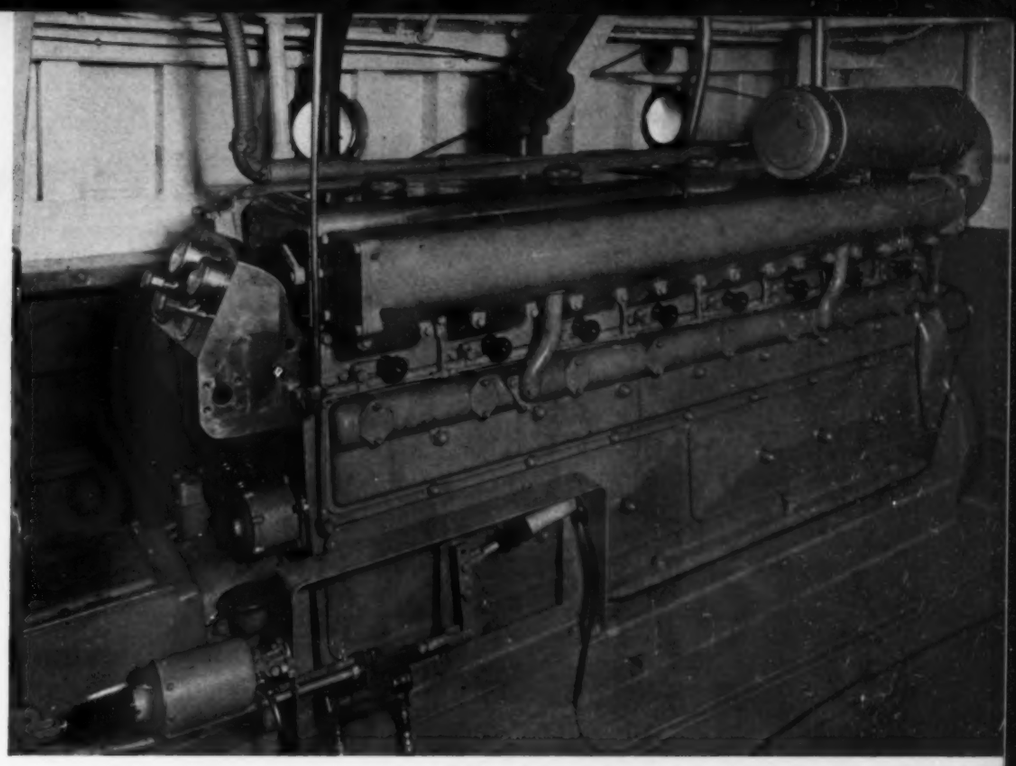
In the fall of 1936 the Inland Navigation Company of Seattle developed plans for a 200 foot welded steel, 1,200 hp. tanker-wheat vessel, the *Inland Chief*, soon to leave the builder's yards in Seattle.

This was the first, and what will be the most unique, vessel for inland service ever built. Below, the vessel is a regular tankship. Above deck, she is a floating bulk wheat warehouse, thus able to operate fully loaded upstream as well as downstream — a payload both ways.

Meanwhile Mr. Kirk Thompson of Spokane conceived another idea for conquering the upper Columbia by means of a shallow draft Diesel tug and a light steel tankerbarge to go into service a full year before the Bonneville Dam will be finished and the 50 mile pool above flooded.

December 15th, Mr. Thompson and his family sponsored the trim, flat tug, *Mary Gail*, named for his daughter, and a 90 foot steel barge, and hiked them both to Bonneville Dam and through the locks, just before they were closed for a nine-month period to allow the lock gates to be installed. The *Mary Gail* thus becomes the first of the new fleet on the upper Columbia and will operate through the half completed channels to Attalia, Wash., near the Snake River. A pipe line will be run around Bonneville Dam, permitting a tug or tanker to unload below the dam, bringing petroleum from Astoria and Portland on the sea-level portion of the Columbia, and pump it into the *Mary Gail's* barge above the dam, and thus be taken to Attalia, about 400 miles inland from the Pacific, thence by truck to the Spokane market area, and other Eastern Washington and Oregon points.

Adhering to the theory that a tug and barge outfit is cheaper to build, operate and maintain, the Kirk Thompson project is of widespread interest. Ironically enough, Portland,



One of the two 200 hp. four cycle, high speed, eight cylinder Winton Diesels which drive the tug, "Mary Gail."

which has long led the fight for Columbia River navigation, hasn't done a thing toward putting boats on the upper river, and Seattle builders and operators have taken a virtual monopoly on this vast program.

The *Mary Gail* is an all welded (electric arc), lightweight, shallow draft, tunnel stern tug, 60 x 17 x 3½ feet overall, with caulked wood decking and steel sheathed upper house. The pilothouse is directly above the engine room, which has two lightweight, four cycle, high speed 8 cylinder Winton Diesels side by side, and operating through a 3:1 reduction gear, controlled by a vacuum clutch from the pilothouse. Twin rudders are mounted aft of the twin propellers and in quiet water she develops 14 miles per hour, or sufficient speed to buck the Columbia's rapids that lie above the Celilo Canal, about 60 miles above Bonneville.

The barge is a 90 x 30 x 6 ft. 6 in. all electric welded steel affair with a capacity of 100,000 gallons of oil in 16 compartments equipped with large circular expansion domes above each compartment to save space. Painted white to shield its contents from the blistering sun that forever shines on the Columbia Basin, the tug and barge are the first all welded pair ever built on the Pacific Coast. They were designed and built by H. C. Hanson, widely known Pacific Coast naval architect. Mr. Hanson rented the Maritime Shipyards plant in Seattle and was active in the construction and supervision, as well as design, of both tug and barge.

Crew's quarters for four and galley are located in the beamy deckhouse, which has electric refrigeration and a Lang oil burning range, equipped with a Therm burner unit. Her streamlined rudders, Exide battery set and generous use of Formica panelling in pilothouse and engine room make her an unusually well finished little tug.

On the outside voyage from Puget Sound to the Columbia River bar, no difficulty was encountered, although the tug has only a couple of feet freeboard and the Pacific gets pretty rough in December. The barge, weighing 100,000 lbs. light, carried 55,000 gallons of oil on its first trip to Attalia, through the incomplete channels of the upper river, and it proved a feasible venture from all angles. The tug and barge are soon to start regular service on a twice-a-week basis between the upper end of Bonneville Dam and Attalia.

The *Inland Chief* will be placed in service on the lower Columbia, from Portland, Vancouver and Astoria to the foot of Bonneville Dam, and will remain in this service until the dam is finished and opened to traffic late in December, 1937, at which time it will run to Pasco, upstream with oil and downstream with bulk wheat.

The new tug running free on trials.

DIESEL ENGINES

By JOHN W. ANDERSON

No. 3. FAIRBANKS-MORSE MODELS 32 AND 35

WAY back in 1912, a quarter of a century ago, were built the original engines which proved to be the prototypes of the present day models. In the intervening years many successive detail improvements have been made, among which were included the water jacketed combustion chamber, the two-stage combustion principle, open head combustion, and finally the back flow principle of scavenging. And these improvements have brought with them increased economy and greater reliability of operation.

Model 32 is the stationary type and is built in two cylinder sizes and in from one to six cylinders per unit giving a range of from 60 to 450 horsepower. The marine type Model 35, is built only in multicylinder units, and hence does not cover the lower portion of the stationary range. In spite of important constructional differences between the stationary and marine models, they are basically the same engine, and are both built for continuous duty at their service ratings.

Every Diesel engine lives on the air and fuel that it eats, and the air charging problem for the two cycle engine is especially important. Thus the back flow scavenging principle merits attention. The sectional view of the engine and the sectional view of the cylinder with the piston in place at the bottom end of its stroke show just how this principle works. These engines use the pumping action of the piston in the crankcase space to pump the supply of scavenging air. The crankcase of each cylinder is separated from the others and by proper seals on the ends of the main bearings, is made substantially air tight.

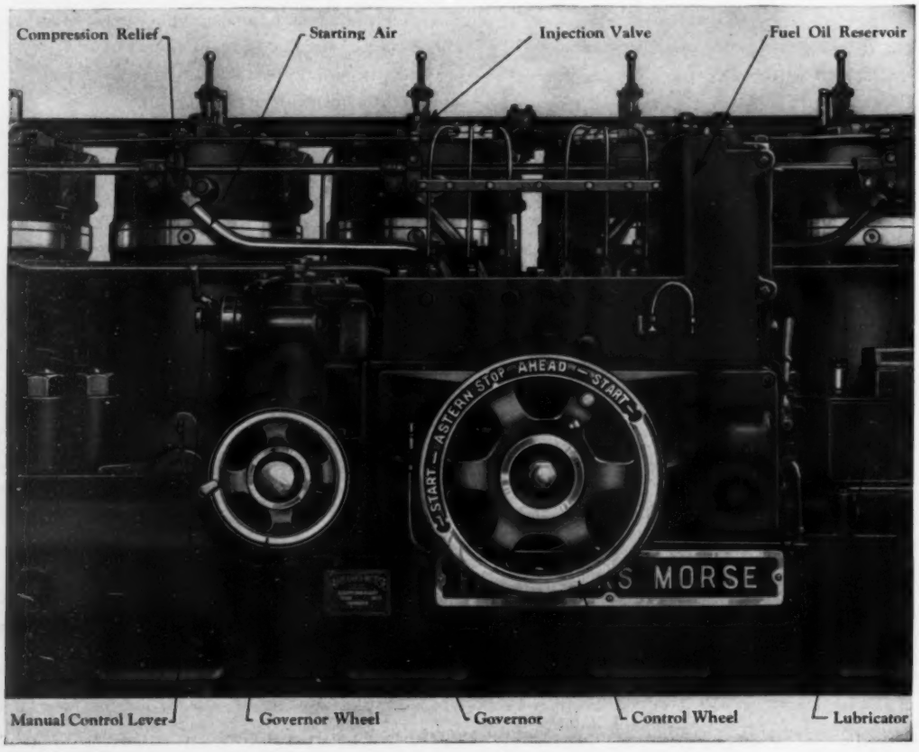
As shown in the engine section, there are air valves on one side of the crankcase which are in communication with the air intake passage. In the cylinder casting are the channels and the ports which connect the crankcase with the interior of the cylinder. On the upstroke of the piston, the cylinder ports are covered, and the piston motion draws into the crankcase space its own stroke volume of air through the air passage and the air valves. On the downstroke of the piston, the air in the crankcase is compressed, but since the exhaust ports in the cylinder are higher than the scavenging ports, they are the first ones to be uncovered by the piston motion. The exhaust gases quickly escape into the exhaust header, and by the time the scavenging ports begin to be uncovered, the pressure in the cylinder has dropped to atmospheric and the cylinder is ready for the scavenging process.

In this process, the exhaust gases must be completely swept out of the cylinder and the cylinder charged with fresh air by the single sweep of the air through the cylinder. Therefore it is important that the process be one of displacement of the exhaust gases by the fresh air with a minimum of intermingling of the two. This is accomplished by the back flow principle. The cylinder ports are so shaped that the air flowing into the cylinder flows convergently upward along the cylinder wall opposite the exhaust ports as shown by the arrows in the illustration. At the top of the cylinder, the air is deflected and turned downward on the exhaust side of the cylinder. Thus every portion of the cylinder space is covered first by the upward and then by the downward flow of the air which in fact does displace the exhaust gases. This scavenging and charging process carries on to completion while the cylinder ports are uncovered. As the ports are closed and the piston starts upward again, the cycle is repeated.

The fuel injection pump and governor mechanism for the stationary engines is shown in the picture, and while the same mechanism is not used for all of the engines, it does illustrate the principle of operation which is the same for all of them. There is an individual pump for each cylinder. The plunger is cam operated and has a constant stroke. The quantity of fuel delivered to the cylinder is controlled by the timing of the seating of the suction valve relative to the plunger stroke, and this timing is under the control of the governor. If the valve seats early, then more of the plunger stroke is utilized and more fuel is delivered to the cylinder so that more power will be developed by the cylinder. But at light loads, the suction valve seats very late and very little fuel is delivered.

The illustration shows only one injection pump, but in the case of a multi-cylinder engine there are more pumps added as needed.

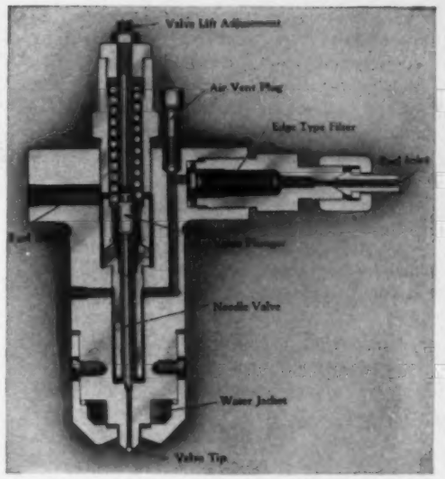
Controls are of the interlocking type and are conveniently centralized for most efficient operation.



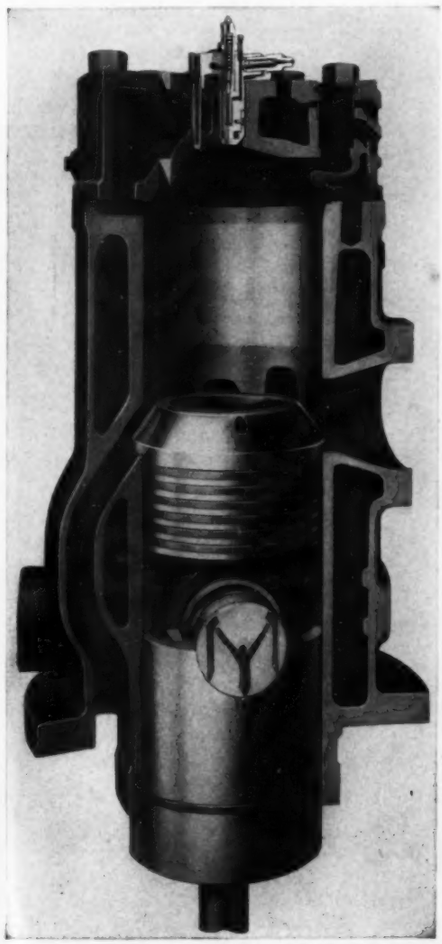
The fuel supply is pumped by the auxiliary fuel pump into the reservoir in which the injection pumps and their suction valves are placed. Thus there is no air in the fuel entering the pumps, the fuel flowing to them under a slight head to ensure complete filling. The plunger is driven by a cam, on the crankshaft in Model 32, but on the camshaft in other cases. The seating of the suction valve is under the control of the governor through an entirely independent mechanism. From the pump, the fuel is delivered through the discharge valve at the top of the pump, through the fuel oil line, to the injection valve in the cylinder head. In the illustration there is shown a shaft governor. The stationary engines are also arranged to be fitted with special governors when needed, and of course the marine engines have a different type of control which will be discussed later.

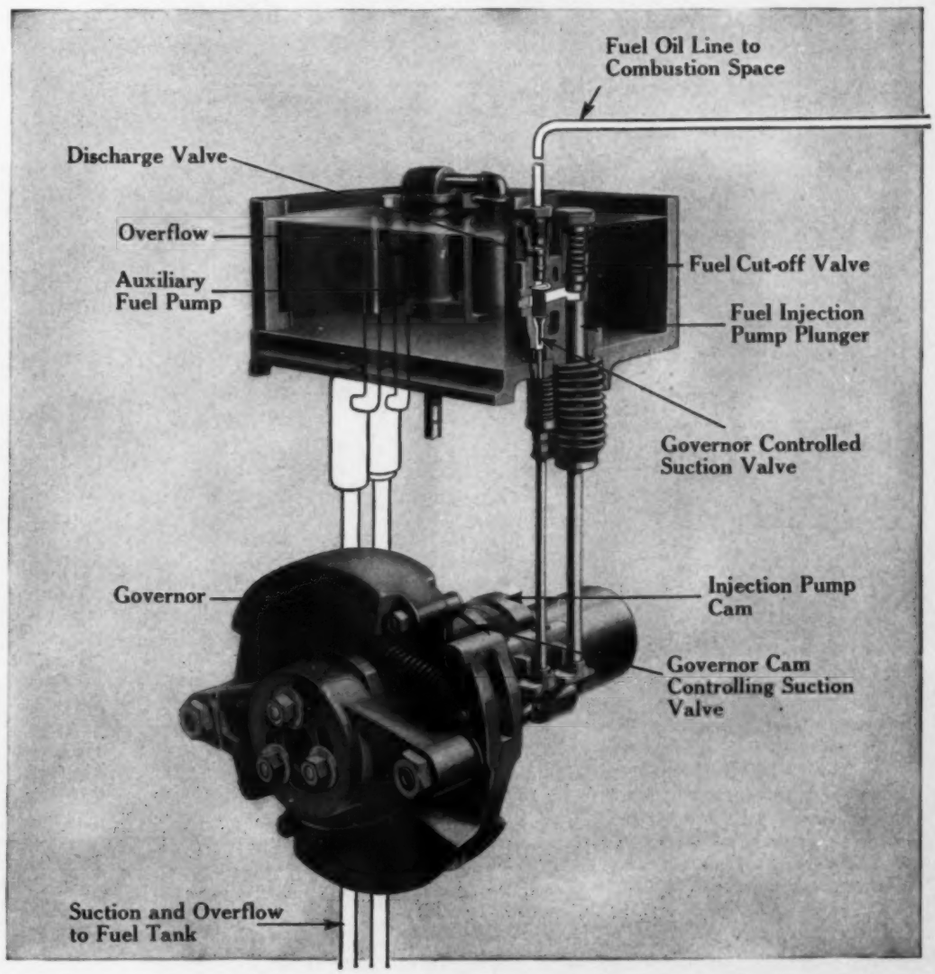
The shape of the combustion chamber is indicated by the sectional views. As the piston reaches the top of its stroke, the beveled outer edge of the piston crown approaches the cylinder head closely, and all of the air is forced into the combustion chamber which is formed by the domed cylinder head and the concave central portion of the piston top. Into this compact chamber is injected the fuel through the injection valve shown in the picture.

This valve is actuated by the fuel pressure, and the pressure at which the valve is opened, that is to say the pressure of the fuel injection, is determined by the loading of the needle valve by the spring back of it. The valve tip is drilled with the size and number of holes needed to properly atomize and distribute the fuel in the combustion chamber. There are several notable features in these valves. There is the edge type filter to ensure nothing but clean fuel getting to the valve. Of course the main filter is ahead of the injection pumps, but the injection valve filter is an added safeguard for stopping stray dirt or tubing scale particles. The air vent plug provides a simple method of venting the tubing between the injection pump and the injection valve when priming the fuel system before starting. The lower end of the valve is water jacketed to eliminate any possibilities of carbonization inside the valve or at the valve spray tip. Any leakage past the needle valve is drained away through the connection marked fuel drain back to the fuel supply tank. The lift of the valve is limited by the adjustable stop at the top of the valve.



The correct combination of fuel penetration and turbulence with no dribbling is assured by the differential injection valve illustrated above. Below: The cutaway section (left) shows arrangement of air ports which assure complete scavenging. Fuel injection and governor mechanism is clearly indicated at right.





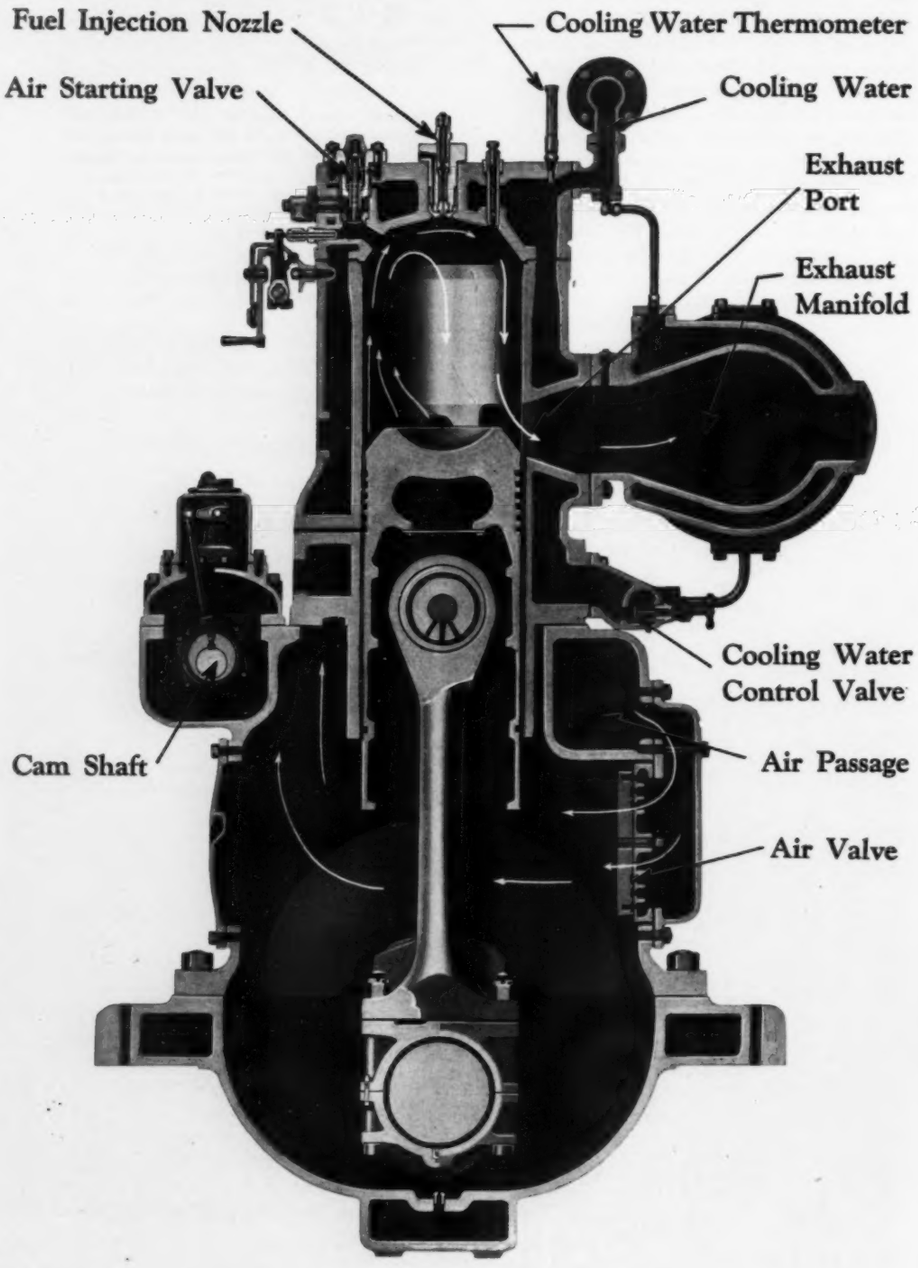
The sufficiency of these scavenging and fuel injection methods is attested by the fuel consumption figures for these engines. The smaller cylinder gives a minimum consumption at full load and speed of 0.40 lb. per hp. hour, and the larger cylinder of these models gives 0.38 lb. per hp. hour.

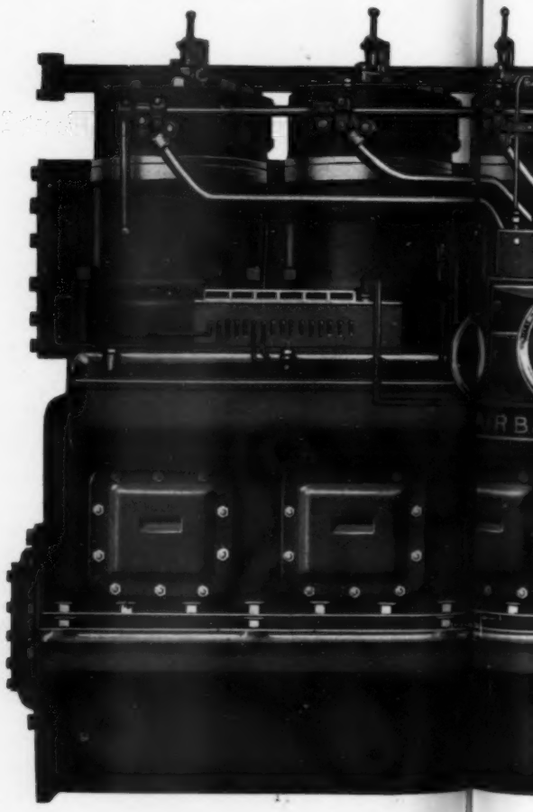
Turning now to the mechanical features of the design, there is one striking difference between the stationary and the marine types. Stationary engines usually are mounted on a concrete foundation, which provides an excellent support for the bedplate, and thus for the main bearings supporting the crankshaft. So it simplifies the design to make the upper part of the base and the cylinders as individual castings. This construction is clearly shown in the general view of the stationary engine. On the other hand, the marine engine, as shown in the general outside view and in the cross section, has all of the upper bases for all of the cylinders cast together in one housing piece for the entire unit. Then when this box section is bolted to the bedplate, the two of them combined form a very rigid structure capable of maintaining the main bearings in line without assistance from the engine foundation.

In the marine engine the fuel injection pumps and the controls are at the side of the engine and a camshaft is used. This is carried in a trough which is cast as a part of the upper base or housing.

The cylinder liner and jacket are in one casting. This eliminates gas and water joints and simplifies the construction when there are so many port openings through the cylinder walls as there are in the two cycle engine. The cylinder head bolts to the top of the cylinder and the jacket water flows directly upward through the cylinder jackets and into the head jacket space. The engine section shows the simple water cooling system with the supply header running along the back of the engine, with branches to each cylinder jacket space and to the exhaust header jacket. The flow through the cylinder jackets can be controlled by valves, and all of the water is collected in the header at the top of the engine. The stationary engines have open funnels between the outlet from each cylinder and the outlet header visibly assuring the operator of correct flow of cooling water.

One other item in the cross section and a very important one, the design of the piston. The





The vertical cross-section shows the extreme simplicity of construction with the absence of intake and exhaust valve mechanism. At right, the partially cutaway longitudinal section indicates clearly the path of lubricating oil to all vital parts and thence back to the filter.

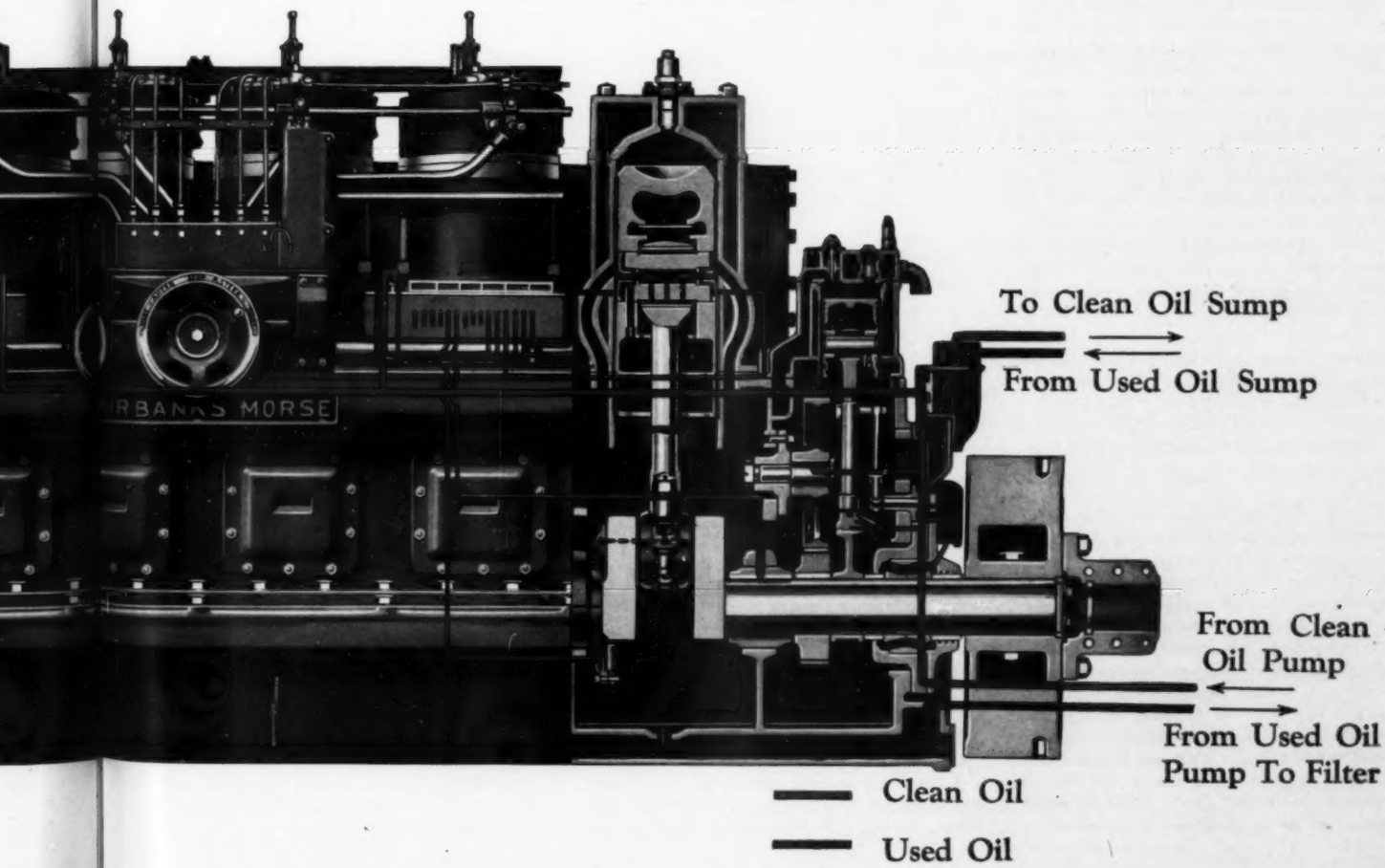
heavy metal sections at the top dissipate the heat, the division plate above the wrist pin prevents the lubricating oil from carboning up from contact with the underside of the cylinder head, and the long barrel comprising the lower part of the piston with the circumferential ribs inside gives very little side thrust to the cylinder wall per unit of area.

The lubricating system of these engines has some special features because of the divided construction of the crankcases. The system is entirely automatic during the operation of the engines and no hand oiling by the operator is required. In the case of the stationary engines, the main bearings are ring oiled and each bearing has its own well of lubricating oil, but all of them are cross connected by piping, thereby assuring equal and constant oil supply to all bearings. A mechanical lubricator supplies oil to the cylinders through the connections in the cylinder walls as shown in the engine sectional view, and through collector rings to the crankpin bearings. The wrist pin bearings are of the needle roller type and are lubricated by the oil fed to the cylinder wall scrapers at the ends of the wristpin. All oil which has been contaminated by combustion drains to a sump at the end of the engine, and is pumped by an engine driven pump to the filter tank outside of the engine. This oil after being thoroughly cleaned drains back to another pump and is used over again. This system is unique in that no dirty oil is ever circulated in the engine.

The system used for the marine engines is similar. Here the mechanical lubricator supplies oil to the main bearings as well as to the cylinders, wristpin bearings, and crank bearings. All of the oil drains to a trough on the under side of the bedplate (it is shown in the engine cross section) and is pumped to the filter outside of the engine, then is returned to the lubricators. The cams and bearings on the camshaft run continuously in an oil bath.

The controls for the stationary engine are concentrated at the end of the engine at the fuel injection pump. Here are the governor, fuel injection pump, and the air starting cam and timing valves. For controlling the starting, there is a single lever which when thrown to the starting position opens a rotary disc valve admitting air to the timing valves. This engages the timing valve rollers with the single cam on the crankshaft. The starting valves in the cylinder heads are simple spring loaded valves and are shown in the sectional views.

The marine engine controls are naturally somewhat more elaborate because there are more things to be done. The smaller sizes of these models are available either as direct-reversing, or reversible through a marine reverse gear. The larger sizes are directly reversible. The engine operates under the control of a variable speed governor, and changes in speed are brought about by varying the tension on the governor spring. In addition the reversible engines have a quick changing speed device which acts directly on the governor spindle instead of through a counterspring. The responses to this control are instantaneous. The starting arrangements are similar to those used on the stationary engines, except of course that there are two cams, one for ahead and one for astern motion of the engine. Since these are two cycle engines, they may be made directly reversible in as few as four cylinders, thus making a directly reversible heavy-duty engine available to even the small operator. The starting and reversing of the engine are under the control of the large handwheel, and the governor (speed) is controlled by the small handwheel. Of course the governor sees that the injection pumps supply sufficient fuel to the cylinders to carry the load and maintain the speed for which the governor is set. The marine engines are provided with an overspeed governor which prevents the engine from exceeding a set speed. They have a built-in starting air compressor driven from the crankshaft. There is also a plunger type circulating water pump and a bilge pump. These engines are, accordingly, completely self-contained marine operating units.



GREATEST POWER FROM DIESEL ENGINES

By B. J. VON BONGART

SINCE its inception, the Diesel engine has been confronted with three cardinal demands, namely:

1. Unfailing auto-ignition.
2. Sufficiently high speed.
3. High brake m.e.p.

The first requirement was successfully met by Diesel and his co-workers some four decades since; otherwise there would have been no Diesel engine.

The second demand has of late years been fulfilled by the Diesel fraternity; and today speeds in excess of 4,000 rpm. no longer constitute exceptional performance.

So many men, in various countries, worked and labored for the realization of the high speed Diesel (although the great majority of even today's engines should for the sake of correctness be termed "medium speed" engines) that it is hard indeed to place the credit where it belongs. The early Diesels were decidedly slow speed engines, heavy and cumbersome; the extreme compression ratios then in vogue and the air-injection method of supplying fuel precluded anything deserving to be called high speed. Without fear of successful contradiction it may be said that McKechnie was the first emancipator in the field of hydraulic fuel injection, which became known as the Vicker's Common Rail. It was the subsequent development of jerk-pumps that inaugurated the era of the high-speed Diesel as we know it today.

The third demand is no longer a problem. But before we can speak of how maximum brake m.e.p. may be obtained from a Diesel engine, we should first of all possess a clear conception of the cause or causes underlying a high brake m.e.p.

To begin with, the compression ratios of carburetted fuel engines – commonly known as Otto engines – are of the order of 5:1 to perhaps 7:1; for Diesels they are from 11½:1 to over 20:1. This then means that the negative work that must be performed by the Diesel (the compression) is greater than that of an Otto engine. But this so-called "extra work" is not wasted, since it permits the burning of cheaper fuel and the omission of (electric) ignition apparatus – two items deserving profound consideration. Thinking people are accustomed to pay in some manner for whatever they may obtain, and thus it is but reasonable that, in so far as the Diesel is concerned, the price extracted for the features of cheap fuel and self-ignition should be a somewhat lower b.m.e.p. than one would expect from an Otto engine, which consumes a far more expensive fuel, and which in addition is subject to ignition failures that may happen at the most inopportune moments. But strange as it may seem, the pumping losses are of but secondary importance in so far as lowered b.m.e.p. is concerned; it is the all too moderate speed of the combustion within a Diesel that limits the brake m.e.p. The following may clarify this point.

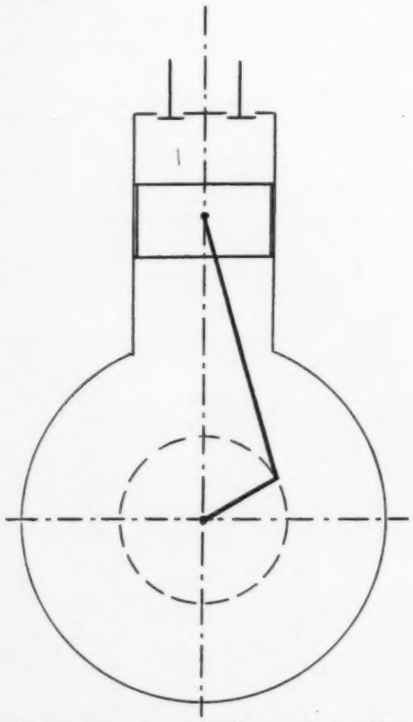


Fig. 1. Time-factor, carburetted-fuel engine. Normal performance.

Needless to say, this is not an attempt to minimize the issue, but merely an endeavor to place different factors in their proper spheres of importance. Pumping losses do exist in all internal combustion engines; their magnitude is of considerable proportion, yet these are not of an all-devouring nature. The major obstacle in the way of the realization of high brake m.e.p. is the slowness of the combustion process. Fully agreeing with the old adage, comparisons are odious, we must, nevertheless, sometimes make them in order to clarify matters. In Fig. 1 is illustrated the time-factor of a well designed Otto engine burning carburetted fuel.

As will be noticed, the entire process of combustion is completed within 60° (crank angle degrees), which may safely be termed good average practice. If the gaseous mixture possesses a well rounded homogeneity and intimacy, then the combustion process may be completed within but 50°. This latter figure, incidentally, represents the very minimum practical in everyday commercial use, as distinct from test-stand exhibitions and laboratory-parades. Detonation – which is but another name for too rapid combustion – takes place when fuel is burned too quickly. And when we say quickly, we mean relatively so, since it still requires from 25° to 40° of crank travel to burn even a gaseous fuel within an engine, and then the combustion is accompanied by detonation, something altogether undesirable. This then places a definite minimum time-limit (time in crank degrees, not fractions of a second) upon the combustion.

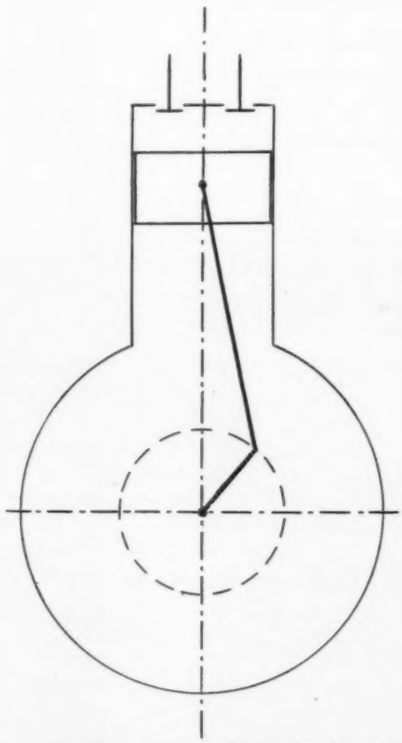


Fig. 2. Time-factor, carburetted-fuel engine. Jerky performance, detonation.

The carburetted fuel or Otto engine has reached a comparatively high state of development not because it possesses inherent superiorities, but rather on account of the long period of step-by-step refinements it has been subjected to. And we must not forget that a great number of minds have dedicated their intelligence, their labor and research to such engines, which cannot but result in progress. In Fig. 3 is shown the time-factor of a typical Diesel engine.

It is of note that it requires 90° (and in many cases more than that) to complete the combustion process. That this is in part due to the hydraulic fuel injection cannot be denied; the ancient Diesels operating with air-injected fuel did provide a somewhat more intimate mixing of the fuel and air. But since higher and ever higher speed is the order of the day, the jerk-pump provides the means, and air-injection simply cannot meet the modern speed requirements. This then leaves but one avenue to follow, and that is quicker combustion. To what extent quick combustion affects the temperature rise — and hence useful pressure rise — within an engine's combustion chamber is depicted in Fig. 4.

The combustion temperature (T_{max}) of a well designed Otto engine reaches 4,000 to 4,500° F. For the average Diesel engine T_{max} varies from 2,500 to 3,250° F. This is not due to the fuel used, since Diesel oil of 40 degree Beaume and gasoline of 65 degrees Beaume (which are perhaps average values for either) contain roughly 20,000 btu. per lb. and thus should produce — theoretically at least — about the same amount of heat if it were not for the fact that Diesel engines are provided with an extra amount of air (beyond that needed for actual combustion) whereas carburetted-fuel engines usually operate with an over-rich mixture (waste of fuel). And any attempt to increase the combustion temperature of a Diesel engine by means of higher compression temperature (higher compression ratio) is doomed to failure, for that would presuppose that with a rise in T_2, T_{max} would rise *pari passu*, which unfortunately is not the case.

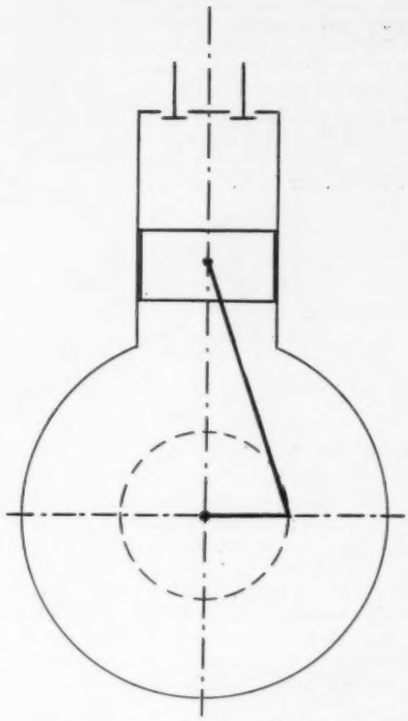
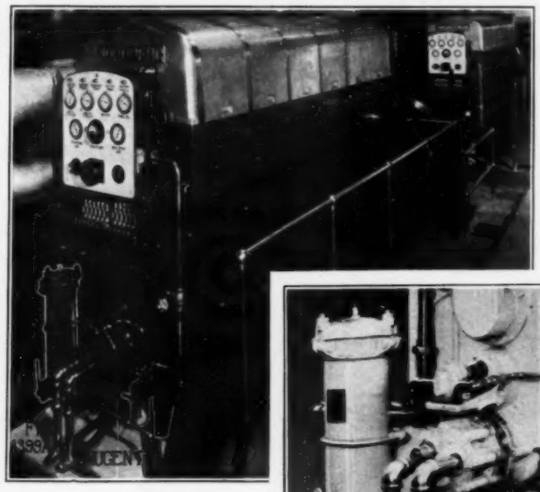


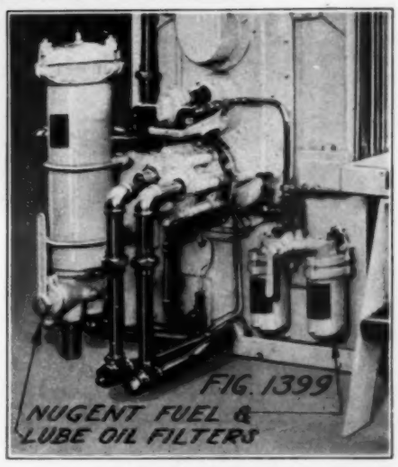
Fig. 3. Time-factor, Diesel engine.

But let us for the moment brush aside the question of maximum temperature and its effect upon the combustion process, which in turn has the determining effect upon the brake m.e.p. produced. Let us compare pressure rise, Diesel vs. Otto engine. Fig. 5 illuminates this.

In a well designed carburetted-fuel engine, the negative work (compression, friction, etc.) absorbs from 6 per cent to 7 per cent of the total power generated. As has been said before, the compression ratio of a Diesel is higher than that of a carburetted-fuel engine, and quite naturally, the negative work that must be performed is thus higher. But here again, the lower b.m.e.p. is not caused by the "extra" negative work; the latter merely aggravates the result of a cause already existing, namely, the slow combustion, Fig. 3. Scrutinizing Fig.



Interior of engine room, showing the 2 Nordberg 300 H.P. Diesel Engines.



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5 a little more, we find that a well designed carburetted-fuel engine for a P_{max} of from 300 to 450 lbs. (equivalent to a T_{max} of from 4,000 to 4,500° F.; see Fig. 4) produces a b.m.e.p. of perhaps 130 to 150 lbs. per square inch, whereas a poorly designed Diesel with a P_{max} of from 525 to 900 lbs. (for a T_{max} of from 2,500 to 3,250° F.) nets a b.e.m.p. of from 80 to 100 lbs. per inch².

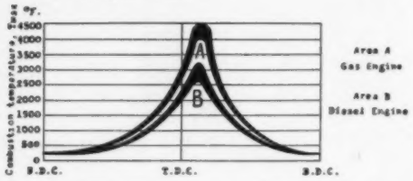

Fig. 4. Temperature rise, carburetted-fuel vs. Diesel engine.

If the above is indicative at all, it shows conclusively that the compression pressure must be held down, for one thing, to reduce the negative work; but mainly, that the combustion process should be speeded up. How low a compression ratio may be used in a Diesel engine depends upon the compromises we are willing to tolerate, such as catalytic ignition, excessive pre-heating of the inducted air charge, late opening of the intake valve in order to produce a vacuum within the engine's cylinders and other measures, ad infinitum. For stationary Diesels operating at a governed speed, we can readily reduce the compression ratio to about twice the value customary in modern Otto engines. But for Diesels that, perforce, must operate at variable speeds, such as marine, locomotive and vehicle engines, a certain minimum compression ratio is imperative, as illustrated in Fig. 6.

Since the combustion temperature T_{max} would at its lowest value be roughly 100 per cent greater than the compression temperature T_2, it is evident that at ¼ load, 1,475° F., would indicate a compression temperature (T_2) of some 737° F. Fuel of average quality will ignite at 650° F. or thereabouts, but it is generally conceded that a compression temperature of 700° F. represents the safe minimum; hence 737° F. (more or less) is but the margin necessary for the reduction of the ignition-lag to workable proportions. The engine in question has a compression ratio of 13:1, which plainly cannot be much lowered.

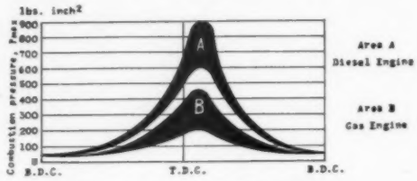

Fig. 5. Diesel vs. Otto engine.

The problems of the Diesel are diametrically opposed to those encountered in carburetted-fuel engines. The latter when operating upon Beau de Rochas' *cycle à quatre temps* — perhaps better known as the Otto four-stroke-cycle

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— have a tendency to approach de Rochas' theorem of "instantaneous combustion at constant volume." But as shown in Fig. 2, too rapid a combustion is a handicap if anything, and should be avoided at all costs. Thus in so far as carburetted-fuel engines are concerned, the combustion process is retarded by so designing the combustion chamber that quick combustion (detonation) may not take place. Doped fuel (the addition of tetra-ethyl-lead) will accomplish the same result, i.e., prolong the combustion process, but well designed engines will not knock with ordinary fuel.

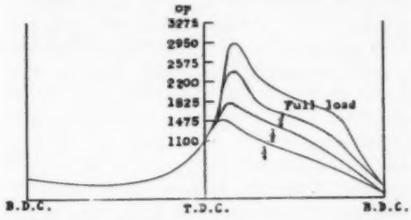

Fig. 6. Combustion temperatures of a European two cycle Diesel at ¼, ½, ¾ and full load.

Quite different is the action within a Diesel. Such engines are said to operate upon the principle of constant pressure and, as we note from Fig. 3, the combustion process is rather extended. Thus we realize that in carburetted-fuel engines the combustion process is inherently tempestuous (unless the compression ratio is held low), and strong measures must be taken to mollify it to safe and workable proportions. The combustion process within a Diesel engine, on the other hand, is unnecessarily docile and should be made as turbulent as possible so as to raise the combustion temperature to the highest safe level, so that the combustion may be speeded up to just short of detonation. For Diesels, too, doped fuel will have its effect, but in the opposite direction; it will reduce the time of the combustion process considerably, but at an extra cost, since such fuels are expensive. It seems but logical to advocate the avoidance of premium fuels, since they are attempts to cure the effect rather than rectify the cause. Reasonably quick combustion in a Diesel can and should be obtained by so designing the combustion chamber that the entire process of combustion will be ended some 60° past T.D.C., in which case there is no need for high priced fuels.

Extensive research has proved that in a divided — or rather sub-divided — chamber, combustion takes place more rapidly than in a single large chamber in so far as Diesel engines are concerned. Whether the dividing of the combustion chamber results in a pre-chamber, ante-chamber, by-chamber or companion-chamber (so-called air-cell) construction is immaterial here, since we should avoid abstract nouns in this discussion or at least not meander beyond the scope of this article.

For the Diesel engine, the entire problem of obtaining the highest possible brake m.e.p. and hence the greatest power, may be summed up by saying: speed up the combustion process.

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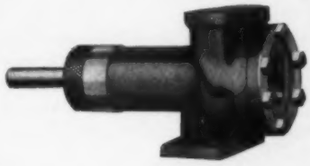

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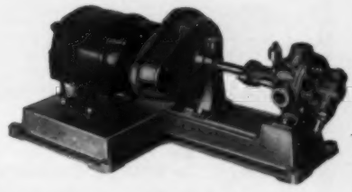

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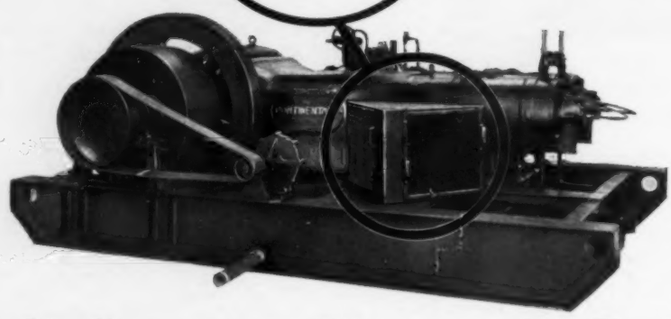

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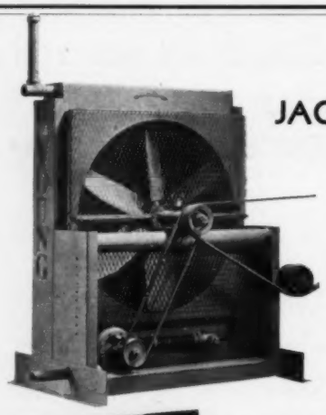

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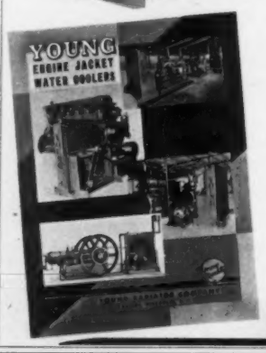

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THE NAMM O

THE Namm Store Diesel Plant,* which was designed and erected under the supervision of Madeheim and Rosenthal, Engineers, has now operated satisfactorily for a period of eight months. These eight months were the most critical in the life of the plant, since it is during the initial operation of a plant that major mechanical or electrical difficulties of any kind usually develop. The plant actually assumed partial load earlier in the year, but May 1st marks the beginning of the first full month with the plant carrying complete load, as the date of actual assumption of full load was April 20th. The transition from the lighting company services to the plant was made by eliminating the various services by steps. The majority of the store personnel were not aware that this change over was taking place, nor were they able to identify those portions of a floor supplied by the lighting company services as differentiated from those portions supplied by the plant.

Numerous questions were raised when this plant was first considered, among which were the following:

I — Will it give good service?
II — Will it create noise?
III — Will it create vibration?
IV — Will it provide the same reliability as the lighting company?
V — Will it take care of the peak loads satisfactorily?
VI — Will it pay?

I — Will it give good service?

It has been impossible to differentiate between the services given by the plant and the utility service, which is not surprising as there is no reason why there should be any difference in the character of the service. None of the personnel were able to identify the changeover, nor has any change in operation of the store resulted.

In addition, a great deal of obsolete electrical work which had given trouble in the past and was threatening to give trouble again in the future was eliminated with the installation of the plant. Further, the control of various parts of the building is now centralized as it never was before, which means that in the event of difficulty of any kind current can be supplied, or shut off, in certain parts of the store at all times from a central point.

II — Will it create noise?

Normal operating noises are heard in the engine room, as was known and expected, but the design is such that this noise is not trans-

**A complete description of the Worthington Diesel installation at the Namm Store appeared in the July, 1936 issue of* DIESEL PROGRESS. *A thorough discussion and explanation of the heat balance followed in the August, 1936 issue.*

OPERATING REPORT

mitted to selling space in any way, and customers entering the store have no method of knowing that a plant capable of supplying the entire building with light and power is operating beneath them.

III — Will it create vibration?

Due to the careful design of the Korfund spring foundations for the engines, it has been possible to keep vibration down beneath the level of vibration caused by existing conditions and traffic, despite the fact that the building used for the installation was not a new one.

IV — Will it provide the same reliability as the lighting company?

Perhaps the strongest point for the plant is the increased reliability which has been given the store through the generation of its own power. The past year witnessed numerous disasters to stores and buildings supplied by the utilities. It is admittedly unfortunate and largely a matter of coincidence that so many disasters fell within the space of one year, but any of these disasters could happen again.

The Namm Store Diesel Plant load ordinarily is carried by four units, although there are five installed. Should one of these units fail, the remaining units would carry the load. To contemplate failure of more than one at a time is far fetched, and even if some great disaster overtook it stranger than that which overtook the large utilities, and two units should fail, the store could be kept open with sufficient light to carry on business. In other words, total failure of power in The Namm Store is highly improbable. Despite the six services formerly supplying The Namm Store, in the event of any disaster similar to that which occurred to the utility companies in other localities, the store would have lost either all the elevators, or all the lighting, or both.

V — Will it take care of the Peak Loads satisfactorily?

The plant has now operated through a Xmas peak with no difficulty whatsoever.

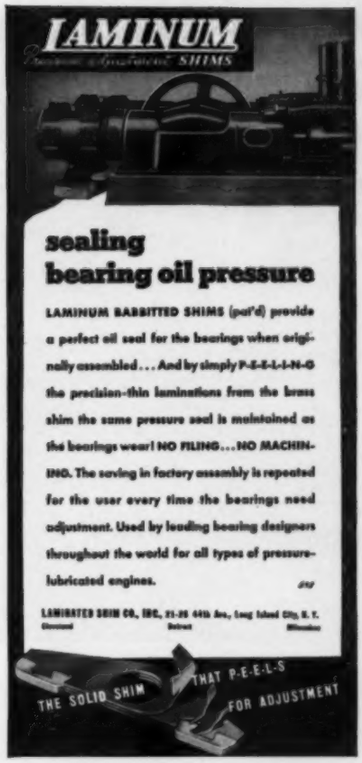
VI — Will it pay?

During the first eight months a saving of 60 per cent over utility cost was shown. In making this figure the credit for the air conditioning engineer has been taken only for that period during which the air conditioning plant operates. As a matter of fact the four men cover the air conditioning and Diesel Plant jointly, but had the Diesel Plant not been installed it would have been necessary to take on a man with a refrigerating license to devote all his time to the air conditioning during its operation. No deduction has been made for the time of this air conditioning man during the balance of the year, although the equivalent of this man's time is still used in maintaining the air conditioning system as used for winter heating and conditioning.

There is an additional credit due because of summer generation of hot water, which is now supplied by the Diesel Plant at no cost, and the winter heating of the first floor and basement. It is impossible to measure these two savings accurately but estimates indicate they will just about balance the increase in taxes levied because of the addition of the power plant.

It was originally calculated that the plant would require six and one-half years to pay for itself. At this present rate the plant will pay for itself in six years.

These figures are the more remarkable when it is considered that they represent the first eight months of operation during which the operating personnel had to be organized and instructed in their duties and the usual "break-in-in" and adjustment of the machinery had to take place. To the credit of the plan personnel it should be said that they have operated the plant efficiently and intelligently and have shown such pride in the plant that they have cheerfully and willingly kept it as a show plant. Everything has been maintained bright and clean.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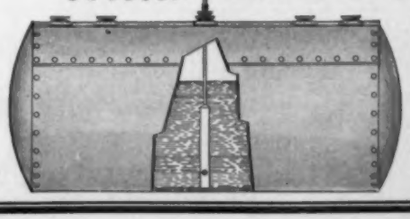

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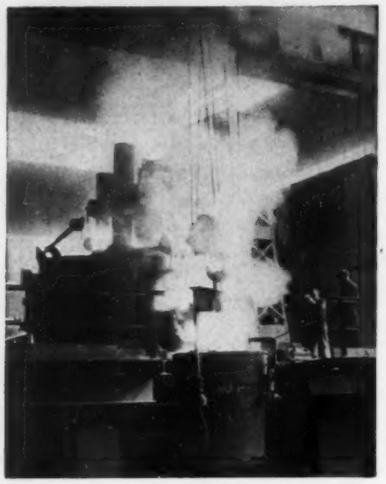

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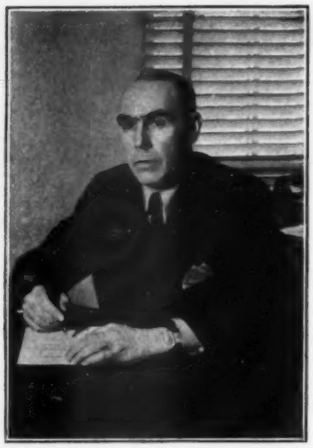

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MR. FRANK A. DONALDSON, President of Donaldson Company, Inc., St. Paul, Minn., manufacturers of Donaldson Oil-Washed Air Cleaners, announces the appointment of Mr. J. S. Naery as Assistant to the President. A steady increase in business has necessitated this addition to the executive staff, and the Donaldson Company feels fortunate in securing the services of so capable a man.

Mr. Naery is well known throughout the tractor industry, having been connected with the John Deere Tractor Company in Waterloo, Iowa, for fifteen years, first in the capacity of Production Manager and later in charge of Experimental Engineering. For the past four years, Mr. Naery has been Division Superintendent with the A. O. Smith Corporation in Milwaukee. The background of experience gained with this company will add to Mr. Naery's value in both the production and engineering departments of Donaldson Company, Inc.

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WILLIAM ABILDGAARD, General Sales Manager of The Cleveland Tractor Company, announces the appointment of Paul C. Nordloh as Advertising Manager. Mr. Nordloh comes to the Cletrac organization with a wide experience in the tractor and industrial field. For the past three years he was with Deere & Company, Moline, Illinois, where he was responsible for a large part of the advertising and sales promotional material used on John Deere Tractors. Previously he was for nine years with The Proctor & Collier advertising agency, Cincinnati, as copy and idea man.

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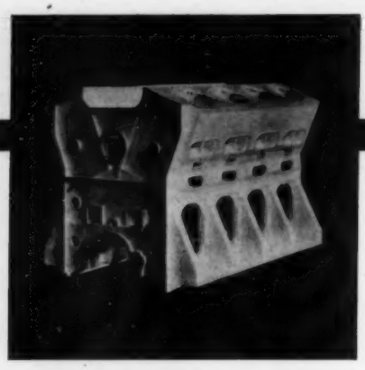

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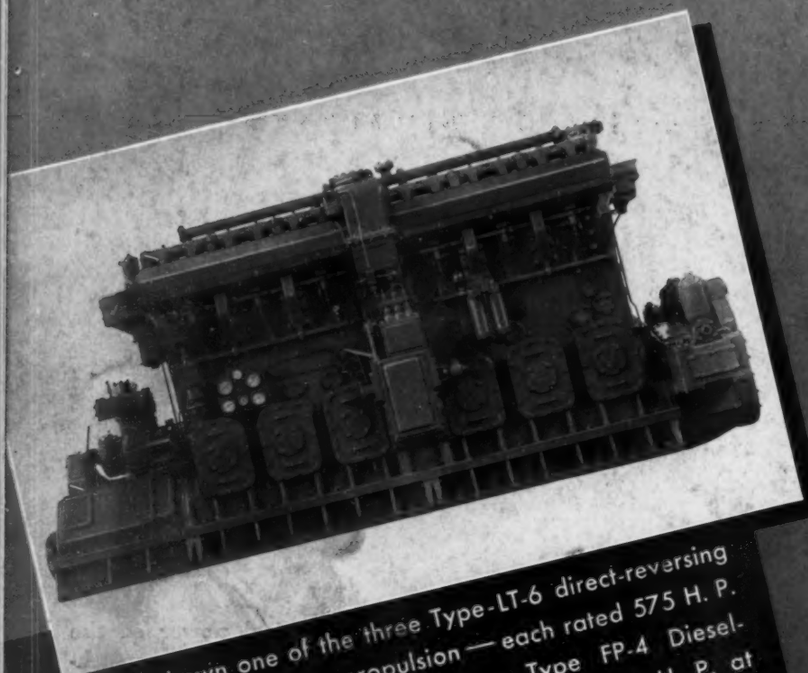

Above is shown one of the three Type-LT-6 direct-reversing marine Diesels for main propulsion — each rated 575 H. P. at 250 r. p. m. In addition, three Type FP-4 Diesel-electric sets are being installed, each rated 140 H. P. at 450 r. p. m.

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